**ES341 Database Management and Attribute Data in GIS**

I. Introduction
   a. Spatial Data – geometry and positions of map features
      i. E.g. line layer representing county roads
   b. Attribute Data – characteristics of features
      i. E.g. information attached to roads including street name, address ranges, zip codes, road type, etc.
   c. Georelational Data Model – attributes and map elements are stored separately and linked by index of a common feature ID code.
      i. Synchronized indexing between feature and attribute files allows:
         1. Queries – questions of data and multiple groups of data and how they relate
         2. Storing of data, retrieval
   d. Raster Model – attributes are attached to grid cells directly, and stored in the same file (i.e. no multiple files)

II. Definitions
   a. Data Tables – matrix of rows and columns
      i. Rows = records
      ii. Columns = fields
   b. Feature Attribute Table – connected to map elements and spatial information
      i. Map elements linked to table attributes by Feature ID
   c. Nonspatial Data Table – isolated matrix of information not attached to map elements or spatial information
   d. Type of Attribute Data
      i. Categorical Data
         1. Nominal data-categories or classes
         2. Ordinal data – ranking information (low, moderate, high)
      ii. Numeric Data
         1. Interval data – ranges of numerical values
         2. Ratio data – numerical values

III. Geodatabase-attributes are managed in tables based on a series of simple yet essential relational data concepts;
   a. Tables contain rows (records), All rows in a table have the same columns.
   b. Each column (fields) has a data type, such as integer, decimal number, character, and date.
   c. A series of relational functions and operators (such as SQL) is available to operate on the tables and their data elements.
   d. **Attribute data types in the geodatabase**
      i. **Numbers:** Can be one of four numeric data types:
         1. short integers-numbers without decimals (e.g. 2, 3, 4; range -32,768 to 32,767)
         2. long integers-numbers without decimals (e.g. 12,345,678; range 2,147,483,648 to 2,147,483,647)
         3. single-precision floating-point numbers (often referred to as floats; decimal-based numbers, e.g. 3.456; range = Approximately -3.4E38 to 1.2E38),
         4. double-precision floating-point numbers (commonly called doubles; range = Approximately -2.2E308 to 1.8E308).
         5. Number Field Definitions
            a. "Precision" = field length (number of characters in field)
               i. Single Float: precision = 1-6
               ii. Double Float: precision = 7+

b. "Scale" = No. of decimal places
    i. Short integer scale = 0
    ii. Long integer scale = 0
    iii. Single Precision Float = 1-6
    iv. Double Precision Float 0+
ii. **Text (strings):** Any set of alphanumeric characters of a certain length.
iii. **Date:** Holds date and time data.

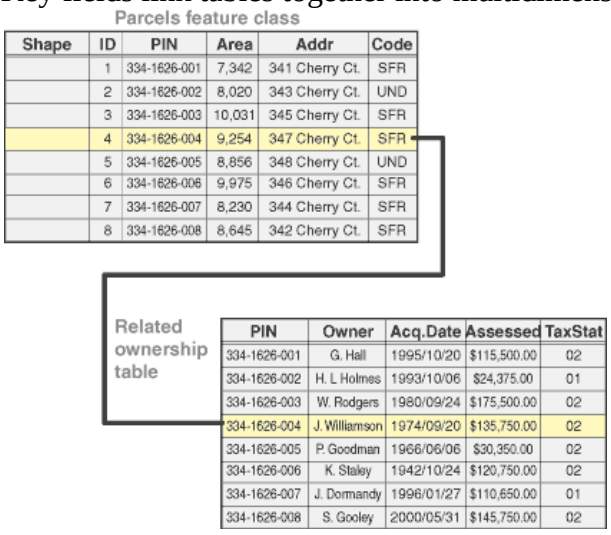
e. Field Definitions
    i. When creating new fields in a database, one must define the field type:
        1. Field name (column title)
        2. Width – number of spaces reserved for the field (precision)
        3. Data type (numeric or string)
        4. Number of decimal digits (scale)

IV. Database Management System (DBMS)

a. Software package that builds and manipulates databases
    i. Tools: data input, search, query, retrieval, manipulation, output
        1. E.g. Microsoft Access, ORACLE

b. Geodatabase – a software system that stores both the spatial (map elements) and attribute data tables in a single database
    i. ArcGIS employs the geodatabase model

c. Relational Database Model
    i. Flat file = all data contained in 1 table matrix
    ii. Hierarchical Data – data organized at many levels so that one-to-many associations can be determined
    iii. Relational Database – a collection of tables linked by relations; allows modular design and data management
    iv. Key Fields – one or more attribute fields whose values uniquely identify a record in a table
        1. Key fields link tables together into multidimensional, hierarchical models




Parcels feature class

| Shape | ID | PIN | Area | Addr | Code |
|---|---|---|---|---|---|
| | 1 | 334-1626-001 | 7,342 | 341 Cherry Ct. | SFR |
| | 2 | 334-1626-002 | 8,020 | 343 Cherry Ct. | UND |
| | 3 | 334-1626-003 | 10,031 | 345 Cherry Ct. | SFR |
| | 4 | 334-1626-004 | 9,254 | 347 Cherry Ct. | SFR |
| | 5 | 334-1626-005 | 8,856 | 348 Cherry Ct. | UND |
| | 6 | 334-1626-006 | 9,975 | 346 Cherry Ct. | SFR |
| | 7 | 334-1626-007 | 8,230 | 344 Cherry Ct. | SFR |
| | 8 | 334-1626-008 | 8,645 | 342 Cherry Ct. | SFR |

Related ownership table

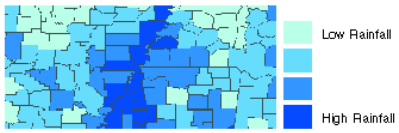
| PIN | Owner | Acq.Date | Assessed | TaxStat |
|---|---|---|---|---|
| 334-1626-001 | G. Hall | 1995/10/20 | $115,500.00 | 02 |
| 334-1626-002 | H. L Holmes | 1993/10/06 | $24,375.00 | 01 |
| 334-1626-003 | W. Rodgers | 1980/09/24 | $175,500.00 | 02 |
| 334-1626-004 | J. Williamson | 1974/09/20 | $135,750.00 | 02 |
| 334-1626-005 | P. Goodman | 1966/06/06 | $30,350.00 | 02 |
| 334-1626-006 | K. Staley | 1942/10/24 | $120,750.00 | 02 |
| 334-1626-007 | J. Dormandy | 1996/01/27 | $110,650.00 | 01 |
| 334-1626-008 | S. Gooley | 2000/05/31 | $145,750.00 | 02 |

V. Types of Database Relationships

a. One to one relations – one record from one table directly related to one record from another table

| Shape | FID | County |
|---|---|---|
| Polygon | 1 | Atoka |
| Polygon | 2 | Kiowa |
| Polygon | 3 | Nowata |

| County | Rain | Total |
|---|---|---|
| Atoka | 1.80 | 10.16 |
| Kiowa | 2.34 | 13.67 |
| Nowata | 1.62 | 11.90 |




b. One to many relations – one record in a table related to many records in another table

| Shape | FID | LU_Code |
|---|---|---|
| Polygon | 1 | 2 |
| Polygon | 2 | 1 |
| Polygon | 3 | 1 |

| LU-Code | Description |
|---|---|
| 1 | Single Family |
| 2 | Agriculture |
| 3 | Commercial |


c. Many to many relations – many records of one table related to many records of another

VI. Joining and Relation Tables (linking multiple tables together)

a. Join – operation combines tables together via a key field; physical merging on tables.

i. One to one or many to one relationships

ii. Spatial Join – associating data based on overlapping positions in space

1. The closest feature to another feature
2. What's inside a feature
3. What intersects a feature
4. How many points fall inside each polygon

b. Relate – temporarily connects tow tables, but keeps them physically separate

i. Unlike joining tables, relating tables simply defines a relationship between two tables. The associated data isn't appended to the layer's attribute table like it is with a join. Instead, you can access the related data when you work with the layer's attributes.

VII. Database Manipulation

a. Adding / removing fields
b. Adding / removing records
c. Computation of attribute data (arithmetic manipulation; field algebra; statistical summaries)
d. Sorting fields (ascending, descending)