GIST 7128
ArcGIS 1: Introduction

Lecture 7
Database & Location Queries

Module 7 Topics

- **Lecture**
  - Database Concepts and Terminology
  - Working with Databases in ArcGIS
  - Selecting Features by Attributes & Location
- **Lab**
  - Chapter **15**. Querying Data
  - Chapter **16**. Selecting Features by Location
  - Chapter **17**. Joining and Relating Data
- **Project**
  - EastCity – Part **4**: Query, Join, and Locate (4%)
  - EastCity – Part **5**: Spatial Analysis (4%)
  - EastCity – Part **6**: More Spatial Analysis (3%)

2

Basic Relational Database Terminology

- **Entity** - a person, place, object, event, or idea
  - i.e. any "thing" you can think about
  - this "thing" is important to the user and needs to be represented and tracked in the database
  - e.g: Employee, City, Street, Graduation, WorkOrder
- Entity Class (a.k.a. Entity Type)
  - a set of entities of the same type
  - described by the structure of the entity
  - e.g. STREET entity class has Name, Lanes, Surface attributes
- Entity Instance (a.k.a. Entity Occurrence)
  - specific member of the Entity class (e.g. a particular Street)
  - described by the values of the attributes of an entity
  - identified by a primary key (e.g. StreetID = 51234)

3

Basic Relational Database Terminology

- **Entity** - a person, place, object, event, or idea (i.e. anything you can think about)
- **Table** – a collection of records that represent an Entity Class (e.g. STREET)
- **Record** (or Row) – a set of field values that describe an Entity Instance (e.g. Main St, 2-lane, paved…)
- **Field** (or Column) – an attribute or characteristic of an Entity Class (e.g. Surface)
- **Field Value** (or Cell) – a single characteristic or attribute of an Entity Instance (e.g. "paved")

4

Basic Relational Database Terminology

STREET Table

Field

StreetID	Name	Lanes	Surface
14587	Main St.	2	paved
14578	Hwy 12	4	paved
14563	Lundy Lane	2	gravel

Record

Field Value

5

Basic Relational Database Terminology

- **Relational Database**
  - a collection of tables
  - a table is known as a "relation" in relational algebra
  - tables are related to one another based on one or more common fields
- **Primary Key** (PK)
  - a field that uniquely identifies a record in the table
  - field values must be unique, not null (& unchanging)
  - could be a collection of fields (Composite PK)
- **Foreign Key** (FK)
  - a field in one table that references the primary key of a second table to form a relationship

6

Relating tables using a common field

Primary Key

Employer Table

Employer ID	Employer Name	Address	City	State/Prov	Postal Code	Phone
10145	The Clipper Ship Inn	5 Cliffside Drive	Rockport	MA	01966	978-546-0193
10146	Newport Mansion Guided Tours	75 Ocean Drive	Newport	RI	02840	401-849-6544
10149	Falling Leaves Tours	389 Birch Avenue	Sturbridge	MA	01566	508-347-5331
10150	Colonial Caravan Tours	91 Bedford Road	Concord	MA	01742	978-371-8086
10151	Granite State Resort	41 Hayward Avenue	North Conway	NH	03860	603-468-8866
10152	Alpine Touring Center	57 Main Street	Bethel	ME	04217	207-824-9976
10154	All Seasons Resort	45 Oceanside Way	Falmouth	MA	02540	508-389-0777

Common Field

Position Table

PositionID	PositionTitle	EmployerID	Wage	Hours/Week	Experience	StartDate	EndDate	Openings
2004	Host/Hostess	10197	17.00	24	☐	07/01	09/30	1
2007	Tour Guide	10146	18.75	20	☑	05/15	10/31	2
2010	Kitchen Help	10135	13.00	40	☐	06/01	10/01	1
2017	Tour Guide	10149	15.00	20	☐	09/21	11/01	1
2020	Host/Hostess	10163	18.50	32	☑	06/15	10/01	1
2021	Waiter/Waitress	10155	9.50	30	☐	06/30	09/15	1
2025	Kitchen Help	10145	12.50	32	☐	07/01	10/01	2

Primary Key *Foreign Key*

7

Basic Relational Database Terminology

- **Relationships**
  - *Informal:* The "glue" that holds the entities together
  - *Formal:* The association between the instances of one or more entity classes
  - Three major characteristics of relationships
    - **Degree** - number of entity classes that participate
    - **Cardinality** - number of instances of one entity class that can be associated with each instance of another entity class
    - **Generalization** - some entity classes are sub-types of other, more general, entity classes
      - e.g. Students are Full-time, Part-time, or Distance Students

8

Basic Database Concepts

- **Cardinality**
  - number of instances of one entity class that can be associated with each instance of another entity class

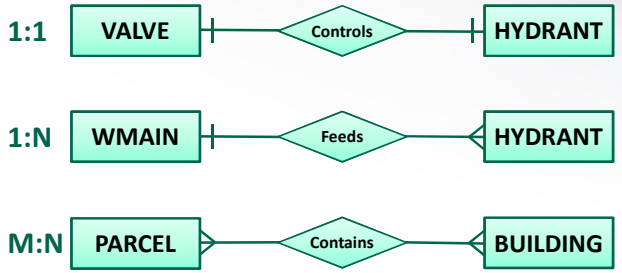
Cardinality	Notation	Graphic	Meaning
One to One	1:1		*Each* **A record** relates with *exactly one* **B record**
One to Many	1:N		*Each* **A record** relates with *any number* of **B records**
Many to Many	M:N		*Any number* of **A records** relate to *any number* of **B records**

  - ***any number*** in this context means "zero or more"

9

Basic Database Concepts

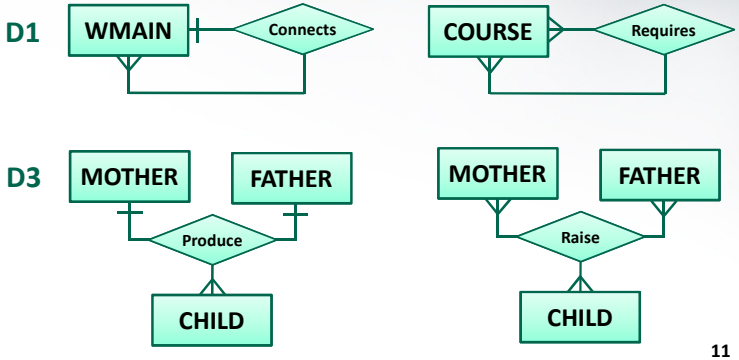
- **Cardinality**
  - number of instances of one entity class that can be associated with each instance of another entity class



10

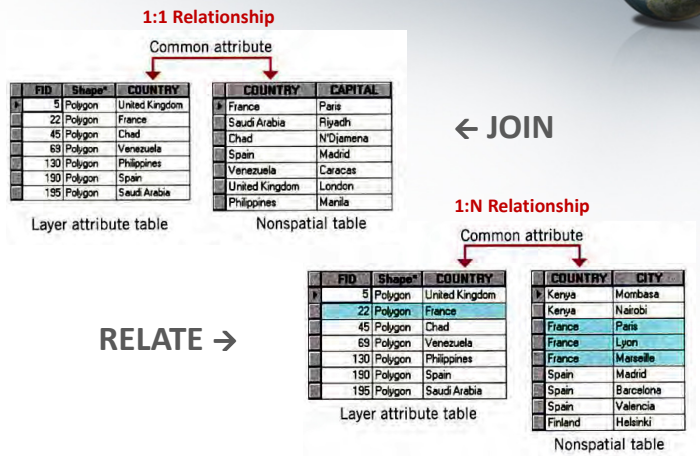
Basic Database Concepts

- **Degree**
  - number of entity classes that participate in a relationship
  - most relationships are binary or degree 2 *(see previous slide)*



11

Table Join and Relate in ArcGIS



12

ArcGIS Relationships

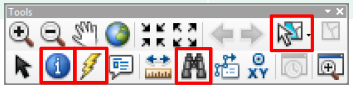
- **JOIN**
  - Two tables displayed as one, 1:1 relationship only
    - *More Precisely:* only **1** FK record can match 1 PK record
  - Virtual Join
    - During map session only, files not changed
  - Permanent Join
    - Export joined tables or layer to a new dataset
- **RELATE**
  - Tables displayed separately, 1:N relationship
  - Virtual Relate
    - During map session only, files not changed
  - Permanent Relate
    - Defined in ArcCatalog (relationship class)
    - Stored in Geodatabase

13

Quick Info Tools

- Different ways to get information on features

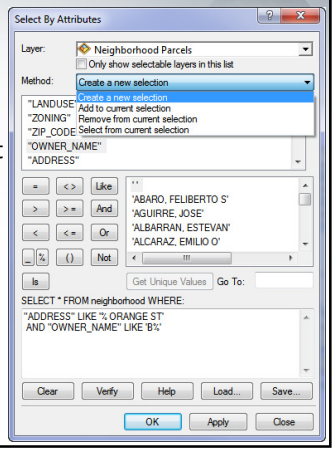
Tool	User Input	Get Info on…	Displayed in…
Identify	Point & click / drag	Single feature	Identify window
Hyperlink	Enable, point & click	Open files not stored in attribute table	Browser or associated application
Find	Enter target text string	Search database attributes to find feature	Find window → Identify or Select
Select Features	Point & click / drag (different modes and methods: New, Add, Remove, "subset")	Multiple Features	Attribute table (with Show selected records)



14

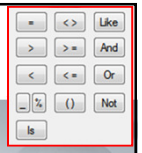
Select Features by Attributes

- Select features based on their attributes
- Requires the "WHERE Clause" of an SQL Statement
- User Inputs:
  1. Layer
  2. Method: New, Add, Remove, subset
  3. Field
  4. Relational (Comparison) Operator
  5. Value (enter or select from list)
  6. Logical (Connection) Operator and repeat 3, 4, 5 (*optional step*)
  7. Verify
  8. Apply or OK



15

SQL "WHERE Clause" Operators



- Form: ***Field OPERATOR Value*** (e.g. PID = 6412)
- **Relational** (comparison) operators – evaluate to True/False

=	equal to	**<>**	not equal to
>	greater than	**<**	less than
>=	greater than or equal to	**<=**	less than or equal to
LIKE	for Text fields only can use wildcards: **%** or **_**	**IN**	for a set of target values, e.g. PID **IN** (6412,6415,6416,6419)
IS	To test for NULL values	e.g.	PID **IS** NULL

- **Logical** (connection) operators – combine multiple conditions

AND	both conds. must be True	**OR**	either (or both) must be True

- **Logical** (negation) operator – reverses an expression's result

NOT	False→True, True→False	e.g.	**NOT** PID = 64; PID IS **NOT** NULL

16

SQL "WHERE Clause" Examples

- WHERE PID = 6412 OR PID = 6415
- WHERE PID IN (6412, 6415)
- WHERE PID IN (6412, 6413, 6414, 6415, 6416, 6417, 6418, 6419)
- WHERE PID >= 6412 AND PID <= 6419
- WHERE Address LIKE '% MAIN ST'
- WHERE Address LIKE '__ MAIN ST'
- WHERE Address LIKE '% MAIN %'
- WHERE Name LIKE 'A%' OR Name LIKE 'B%'
- WHERE NOT (Name LIKE 'A%' OR Name LIKE 'B%')
- WHERE NOT (Name LIKE 'A%') AND NOT (Name LIKE 'B%')

17

Attribute Query & Selection Set

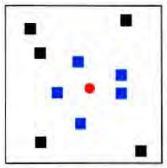
- **Query – a question/request to the database**
  - How many properties on this street?
  - Who are their owners?
  - What is their average value and annual taxes?
  - What other streets intersect this street?
    - Can query data from one or more layers
- **Selection Set – results of a Query**
  - Temporary – until next query run
  - Can be modified →
  - Can be saved in a:
    - EXP (expression) file
    - Results to LYR file
    - MXD

18

Select Features by Location

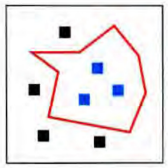
- Select features based on topology
  - i.e. on their spatial relationship with other features

Proximity (or Distance)



Points within a given distance of the red point are selected.

Containment (or Within)

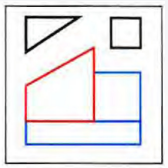


Points contained by the red polygon are selected.

Intersection (or Overlap)

Lines that intersect the red line are selected.

Adjacency (or Touching)

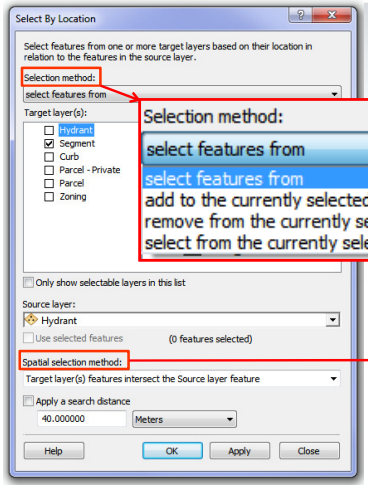


Polygons adjacent to the red polygon are selected.

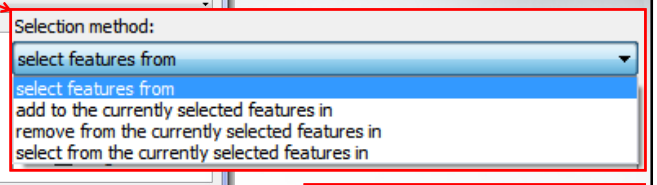
Page 539 in Text

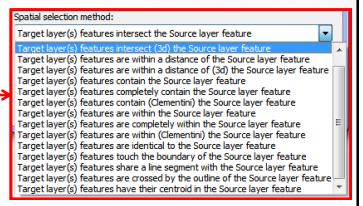
19

Select Features by Location



Opened with:
Selection > Select by Location…





Next Slide…

20

Select by Location

Spatial Selection Methods

Spatial selection method:

INTERSECTION	intersect the Source layer feature
	intersect (3d) the Source layer feature
PROXIMITY	are within a distance of the Source layer feature
	are within a distance of (3d) the Source layer feature
	Target layer(s) features contain the Source layer feature
	Target layer(s) features completely contain the Source layer feature
CONTAINMENT	contain (Clementini) the Source layer feature
	are within the Source layer feature
	Target layer(s) features are completely within the Source layer feature
	Target layer(s) features are within (Clementini) the Source layer feature
	are identical to the Source layer feature
ADJACENCY	touch the boundary of the Source layer feature
	share a line segment with the Source layer feature
INTERSECTION	are crossed by the outline of the Source layer feature
	have their centroid in the Source layer feature

21

Select by Attributes *and* Location

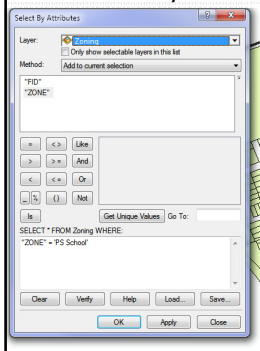
Examples

1. Select Cities with population greater than 100,000 *and* within 10 kms of a major fault line
2. Select Parcels that are zoned as residential *and* are in or touching the flood zone
3. Select Land Use features that are Public Schools *and* then select Parcels that are within 400m of them
4. Select Parcels based on cost and size *and* within 400m of a Public School

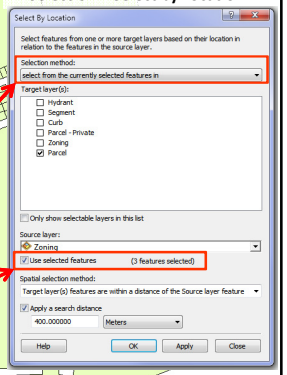
22

Select by Attributes *and* Location

1. Selection > Select by Attributes...



2. Selection > Select by Location...



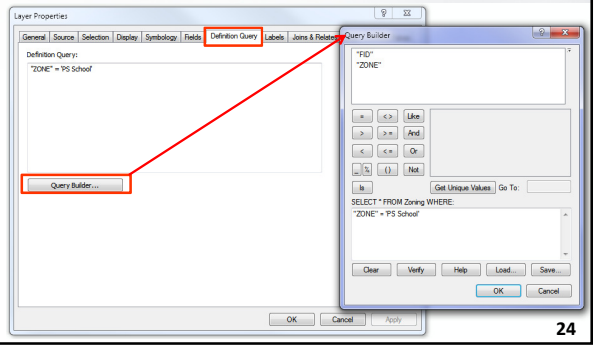
Select features by Attributes *and* Location with one/both of these:

- ...from currently selected features
- ☐ Use selected features

23

Definition Query

- Similar to a Select by Attributes query
- Matching features:
  - Are not selected as in Select by Attributes
  - Instead they are displayed and all non-matching features are hidden
- Entered on Properties window: Definition Query tab



24