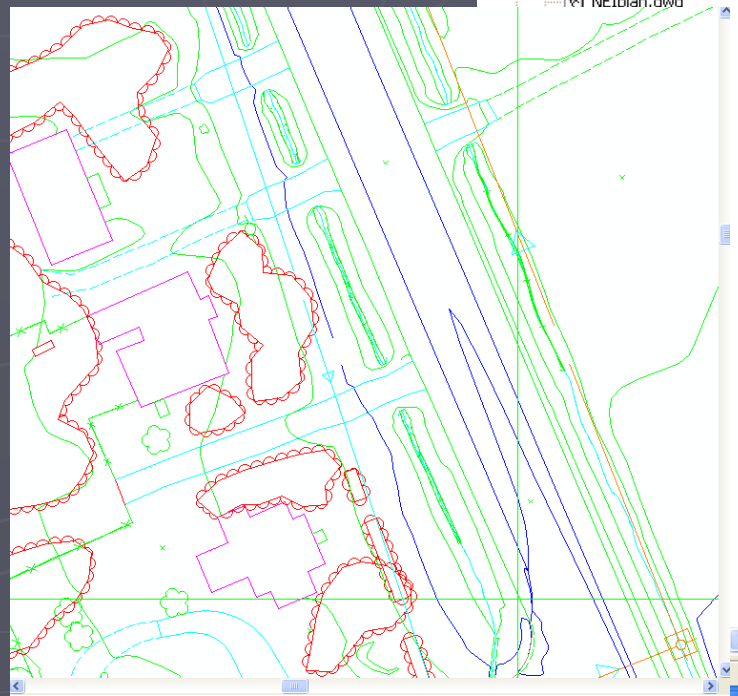
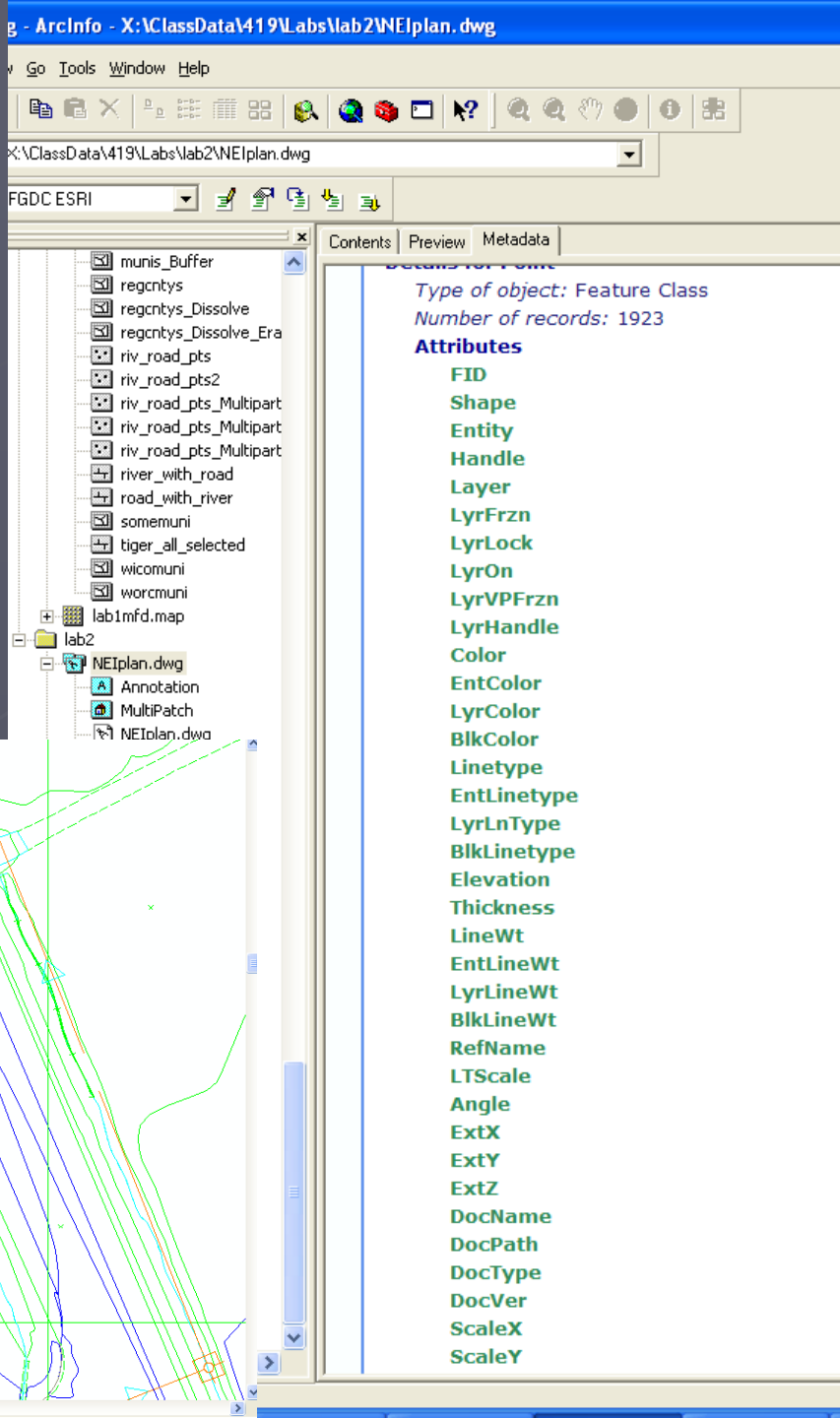
Object modeling and geodatabases

GEOG 419: Advanced GIS

CAD Data Model

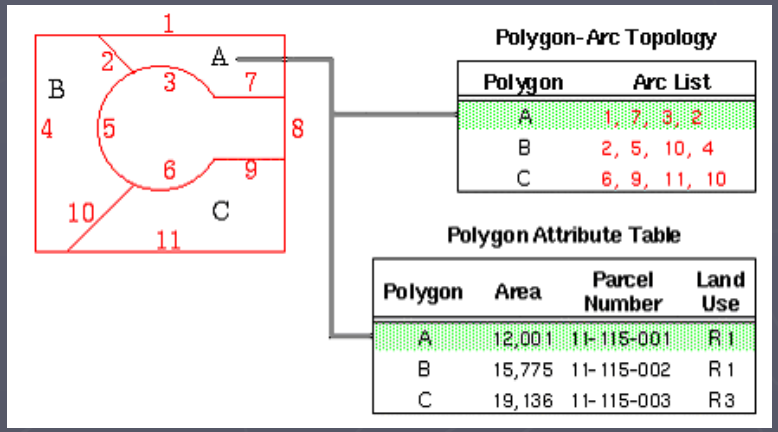
- 1960s and 1970s
- Geographic data stored as points, lines, and areas
- No attributes; each feature type stored on a different layer
- No topology –
- all "spaghetti"





Georelational data model

- Spatial data is combined with attribute data
  - Spatial data indexed in binary files
  - Attribute data stored in separate tables and linked with a common field
- Topological relationships are stored
- Allowed for customization of attributes
- Spatial data not stored in RDBMS because of limitations in hardware and software



Disadvantage of georelational data model

- All features have the same generic behavior
  - Roads: crossing lines should form a traffic intersection (except over/underpass)
  - Streams: downstream lines should sum the flows of upstream lines
  - Overlapping objects
- Anatomy of a shape file

Geodatabase data model

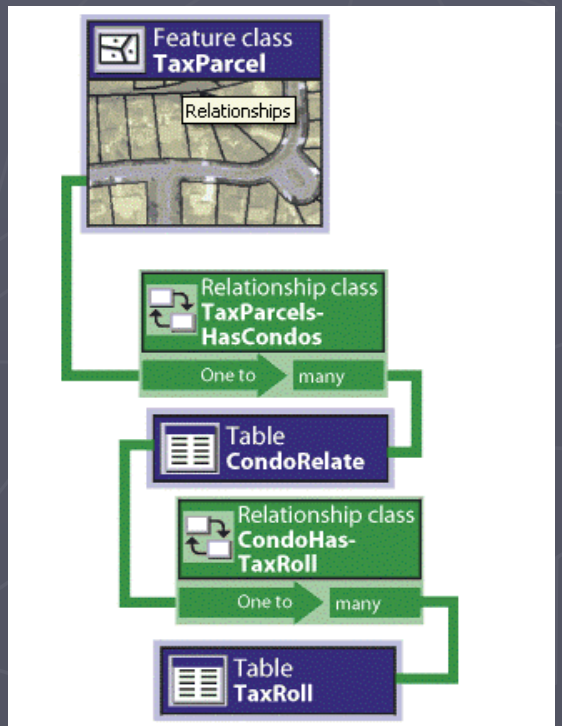
- Allows features to have natural behaviors
- Establish defined relationships between features
- Brings a physical data model closer to a logical data model
  - Owners, buildings, parcels, roads
- Allows custom features to be implemented without writing specialized code

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

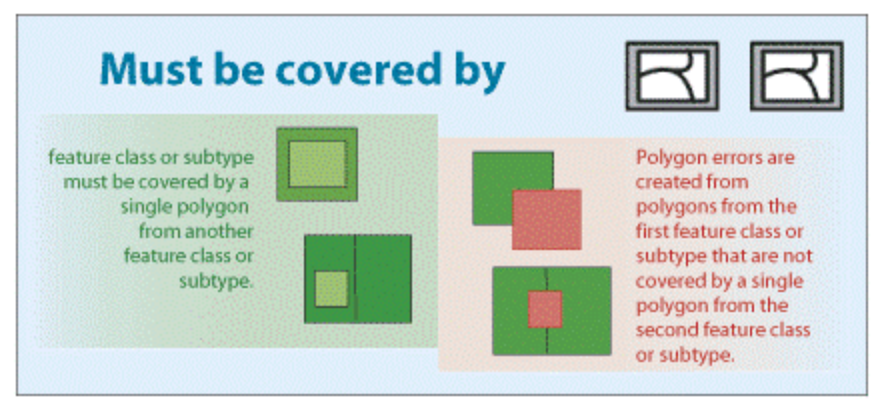
Related ownership table

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



Uses of object behavior

- Adding and editing features
  - Attribute values must fall within a range
  - Adjacency and connectivity tests
  - Conform to a spatial arrangement
  - Geometry matches a set of rules
- Relationships among features
  - Networks should be connected
  - Relationships between features on the map and those not on the map

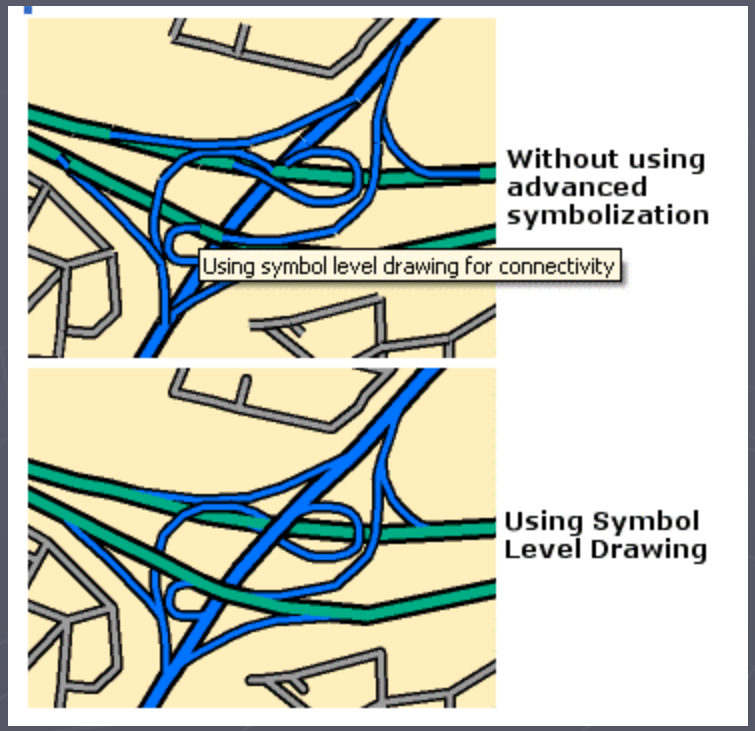


Some feature classes commonly managed in a shared topology

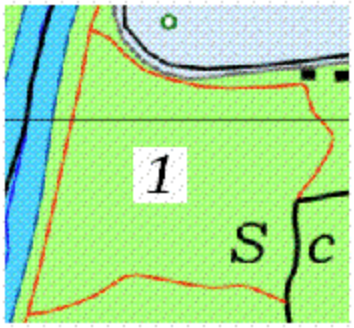
Data Theme	Feature classes	Sub-sample of Topology Rules
Parcels	Parcel polygons	Parcel polygons must not overlap.
	Parcel boundaries (lines)	Parcel polygon boundaries must be covered by Parcel boundary lines.
	Parcel corners (points)	Parcel boundary endpoints must be covered by Parcel corner points.
Street centerlines and census units	Street centerlines	Street lines must not intersect or touch interior.
	Census blocks	Census blocks must not overlap.
	Census block groups	Census block groups must be covered by census blocks.
	Census tracts	Census block groups must not overlap.
		Census tracts must be covered by census block groups.
		Census tracts must not overlap.
Soils	Soil type polygons	Soil polygons must not overlap.
		Soil polygons must not have gaps.
Hydrology	Hydro lines	Hydro lines must not self-overlap.
	Hydro points	Hydro points must be covered by hydro lines.
	Watersheds (polygons)	Watersheds must not overlap.
		Watersheds must not have gaps.

Uses of object behavior II

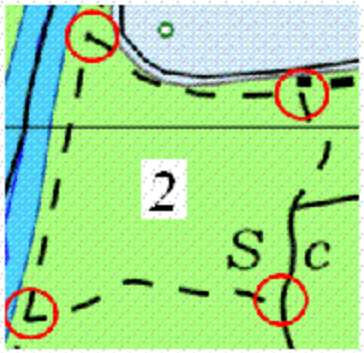
- Cartographic display
  - Auto labeling of contour lines
  - Roads at a large scale are drawn as polygons with clean intersections
  - Coincident lines displayed next to each other
- Interactive analysis
  - Touch a feature and launch an update wizard
  - Select a link and automatically select all downstream links



Map Layers created in ArcMap

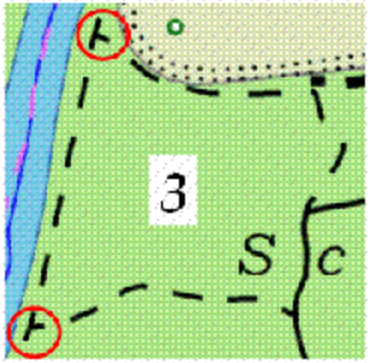


Feature geometry representing trail lines



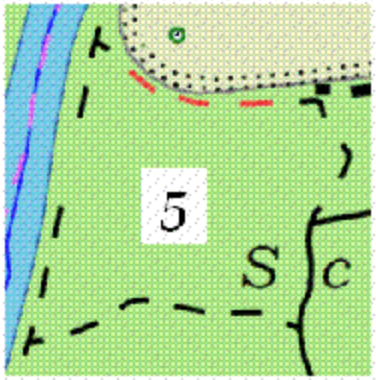
Using layers to represent trails as dashed lines

Example displays using cartographic representations



Using rules for starting all dashes with a half-dash to show connectivity

Using control points so that dashes travel through curves greater than a specified angle



Offsetting dashed lines from other features. Note the representation is offset, not the feature geometry.

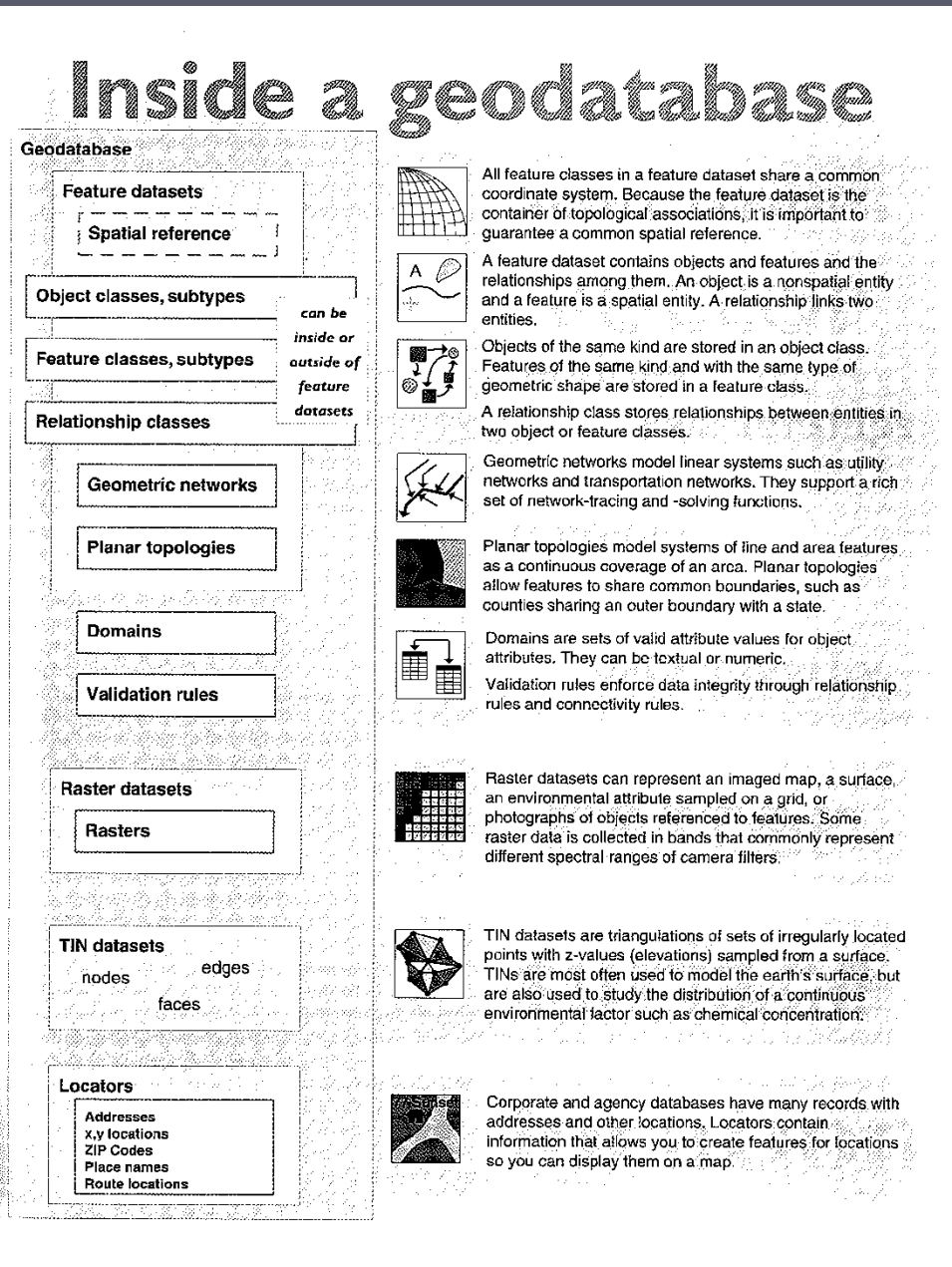
Benefits of the geodatabase data model

- Uniform repository of geographic data
- Data entry and editing is more accurate
- Users work with more intuitive data objects
- Features have a richer context
- Better maps can be made
- Features on a map display are dynamic
- Shapes of features are better defined
- Sets of features are continuous
- Many users can edit geographic data simultaneously

ESRI HELP: If you have a third-party application that accesses the data in your geodatabase, the application can only access the data at the DBMS level, bypassing any of the integrity features you set up at the geodatabase level. To support this application, you may want to implement DBMS constraints and triggers.

Within a geodatabase…
(pg. 9)

- Feature dataset
  - Spatial reference
  - Object (non-spatial) classes
  - Feature (spatial) classes
  - Relationship classes
  - Geometric networks
  - Planar topologies
- Domains
- Validation rules
- *Raster datasets*
- *TIN datasets*
- Locators



Key components of OO

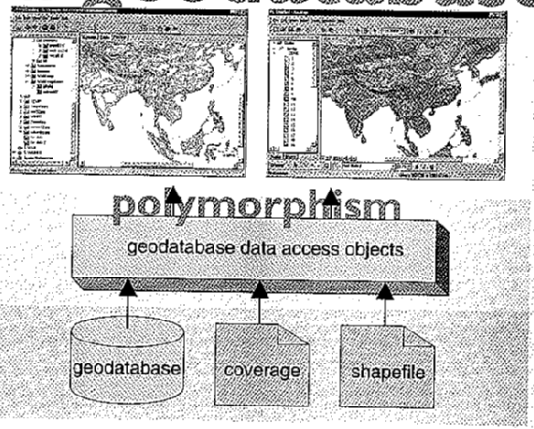
- Polymorphism
  - Behaviors of an object class can adapt to variations of objects (draw, add, delete of geodatabase, coverage, shapefile)
- Encapsulation
  - An object is accessed through well-defined software methods, **hiding the internal details** (drawback is interoperability with other software)
- Inheritance
  - An object class can be defined to include the features of another object class, plus additional behaviors

Features in a geodatabase

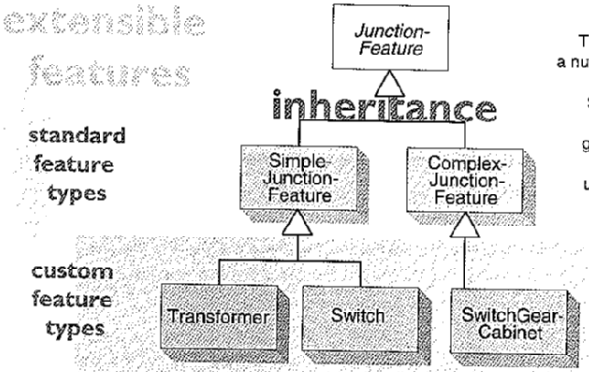
unified data model

ArcInfo is versatile at displaying and analyzing geographic features. ArcInfo works with a number of data sources, including geodatabases, coverages, and shapefiles.

The *geodatabase data access objects* comprise a programming interface that largely hides any differences among feature types from geodatabases, coverages, and shapefiles.



extensible features



The geodatabase data access objects include a number of software components that represent the types of features that are ready for use. Shown here are some of the network feature types. These have intrinsic behaviors that guarantee the topological integrity of features in a geometric network. Most data modelers use standard feature types without extending them through custom programming.

These are some custom features that have been extended from the standard feature types. They implement specialized behaviors for custom applications developed by data modelers and programmers.

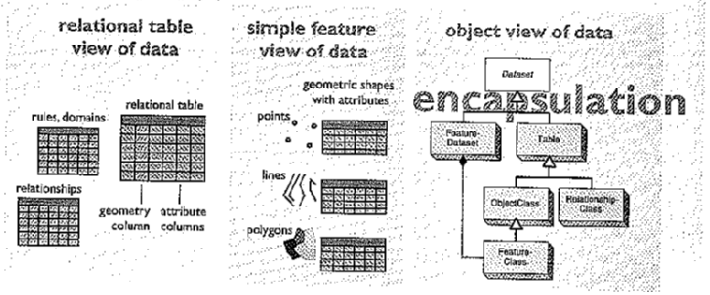
data access

Data can be viewed in three ways.

The relational table view of data exposes the internal details of the physical storage as database tables.

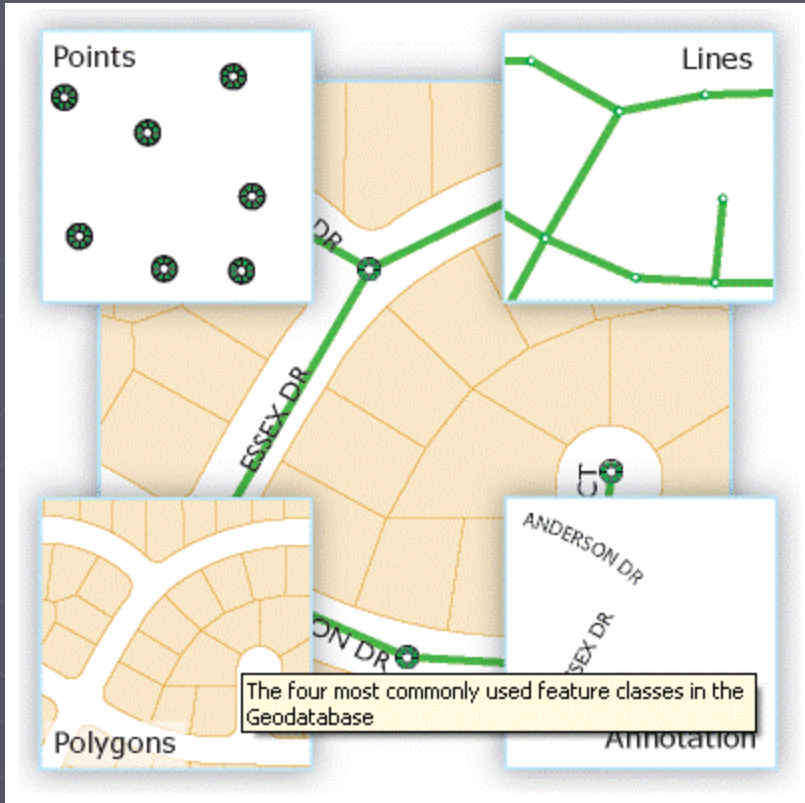
The simple feature view presents data in the form of features without the structure of topology and relationships.

The object view of data encapsulates the internal details and presents a higher level of structure that is closer to the user's conceptual model of data.



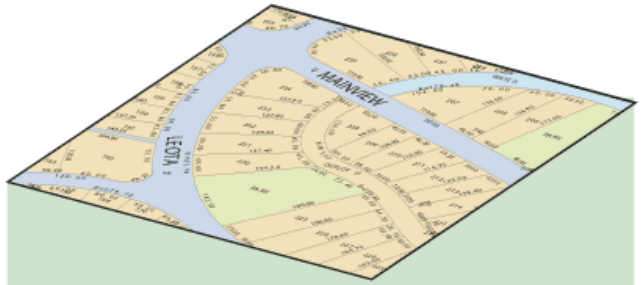
Serving geographic data

- All data is stored in an RDBMS through enhancement
- How does Geodatabase extend an RDBMS
  - Represents 4 types of geo data (raster, vector, address, TIN)
  - Stores shapes of features, coordinate systems (no more .prj)
  - Can model topologically integrated datasets (i.e. networks)
  - Can define relationships between objects and features
  - Can enforce attribute integrity
  - Can bind natural feature behavior to feature tables
  - Can present multiple versions of data
- Personal vs. multiuser geodatabases
  - ArcInfo vs. ArcSDE
  - Both systems interact with the geodatabase



Building a data model

- Designing a logical data model
- Representing logical data model
- Implementing physical database model



Layer	**Ownership parcels**
Map use	Parcels define land ownership and are used for taxation
Data source	Compiled from land ownership transactions at local government
Representation	Polygons in survey-aware feature classes and related annotation
Spatial relationships	Parcel Polygons cannot overlap and are covered by boundary lines
Map scale and accuracy	Typical map scales are 1:1200 and 1:2400
Symbology and annotation	Parcels often drawn using boundary features and related annotation

Classes and Objects

- Abstract class
  - Cannot be used to create new objects
  - Is a specification for subclasses (i.e. a line is an abstract class for a secondary or primary line)
- Creatable class
  - Objects you can directly create
- Instantiable class
  - Cannot directly create new objects
  - Objects created as functions of other objects

Types of Relationships

- Associations – relationships between classes
  - Multiplicity – constraint on associations
    - 1 – 1 and only 1 (default)
    - 0..1 – Zero or one
    - M..N – from M to N (positive integers)
    - * or 0..* - from zero to any positive integer
    - 1..* - from 1 to any positive integer
- Type inheritance – classes that share properties with superclass and have additional properties
- Instantiation – one object from one class can create an object from another class
- Aggregation – asymmetric; object of one class is "whole" another is "parts"
- Composition – stronger aggregation; objects from the "whole" class controls the lifetime of the "parts" class