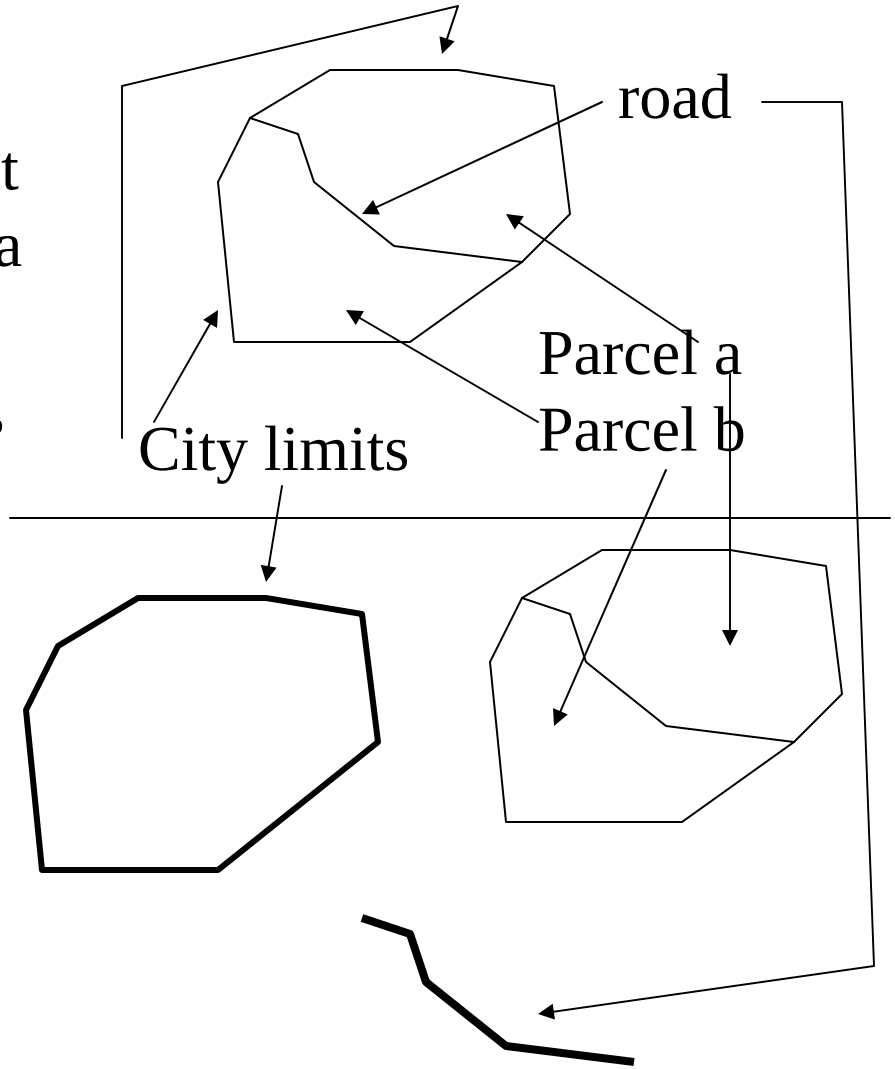
Alternative data structure models

- there are two basic different data structure models with a number of variants
- storage of all map elements in a “combined” structure with multiple attributes associated
- storage of different map elements associated with different themes



Tabular data

TRAFFIC STUDY DATA

Record Number	Household –ID	Person –ID	Person Age	Vehicle –ID	Vehicle Type	Trip –ID	Trip Purpose	Trip Duration
1	101	A	59	10	Car	1	S	75
2	101	B	47	10	Car	1	W	38
3	102	A	24	10	Car	1	C	18
4	102	A	24	10	Car	2	R	24
5	102	A	24	10	Car	3	S	07
6	102	A	24	10	Car	4	C	18
7	102	A	24	10	Car	5	R	30
8	103	A	41	10	Car	1	S	17
9	103	B	38	11	Van	1	W	23
10	103	B	38	11	Van	2	R	54
11	103	B	38	11	Van	3	H	27
12	103	C	17	10	Car		no trips	

Figure 9.1 Conventional table format.

Separation into data themes

HOUSEHOLDS

Household – ID	Number of persons	Income category
101	2	3
102	1	5
103	3	2

PERSONS

Person – ID	Age	Gender
101A	59	male
101B	47	female
102A	24	female

VEHICLES

Vehicle –ID	Vehicle Type	Age
101–10	Car	5
102–10	Car	2
103–10	Van	7

TRIPS

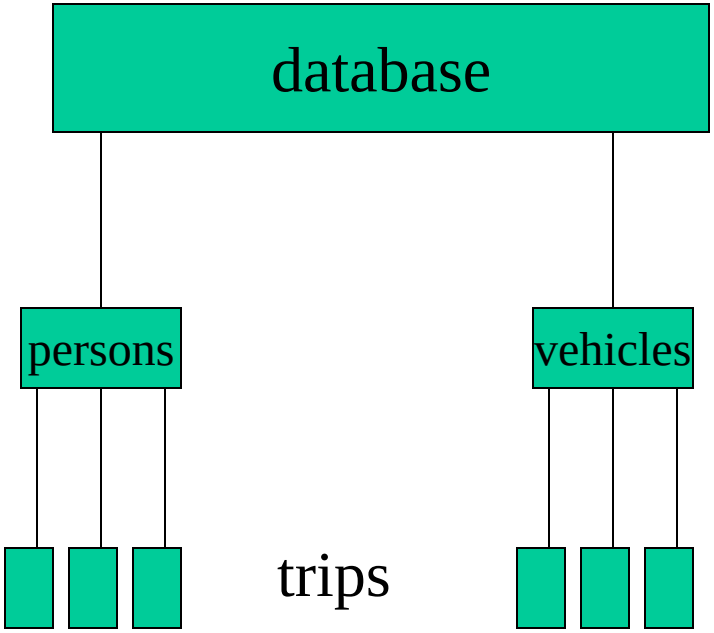
Trip –ID	Trip Purpose	Trip Duration
101A–1	S	75
101B–1	W	38
102A–1	C	18

Figure 9.2 Separation of data themes.

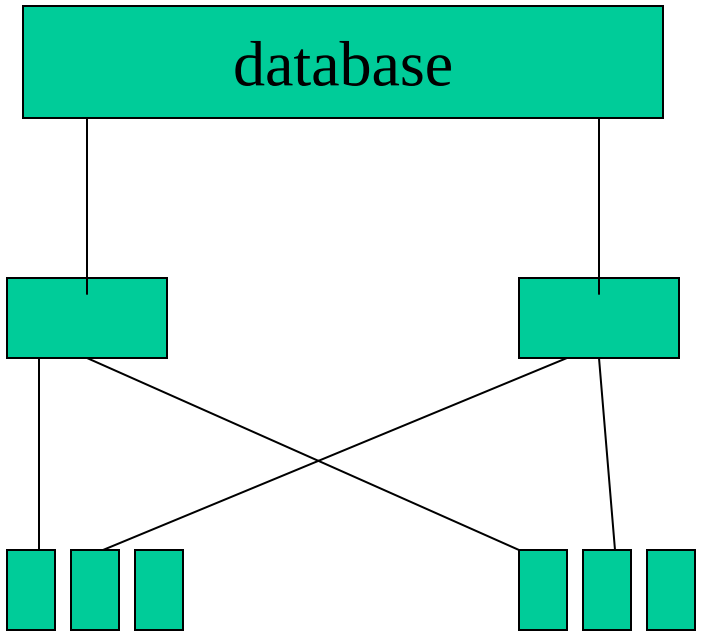
Alternative (older) data structures

- Original structures tended to reflect basic human conceptualization of data
- Hierarchy
  - “larger” conceptual entities contained smaller ones
- Network
  - database pointers permit multiple linkages betweel “lower level” entities and those above

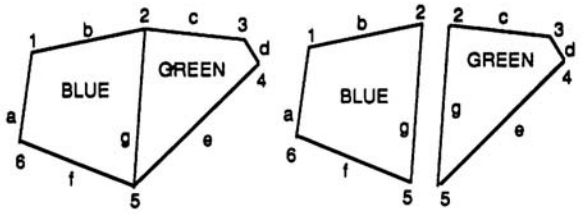
General structures



Hierarchical dbms



Network DBMS



(a) Territory

(b) Parcels, segments, corners

CORNERS

Record number	ID	X	Y
1	1	0.1	1.2
2	2	1.1	1.4
3	3	2.0	1.3
4	4	2.1	1.1
5	5	1.0	0.0
6	6	0.0	0.4

SEGMENTS

Record number	ID	Length
1	a	5
2	b	5
3	c	6
4	d	1
5	e	7
6	f	6
7	g	8

PARCELS

Record number	ID	Size
1	BLUE	25
2	GREEN	17

TERRITORY

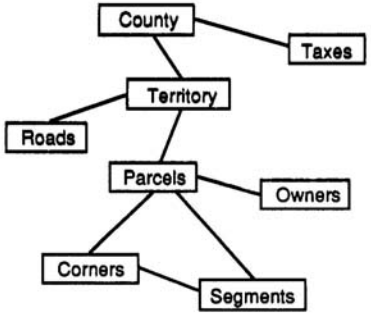
Record number	ID	Map scale
1	East	50,000

(c) Tables of separate elements

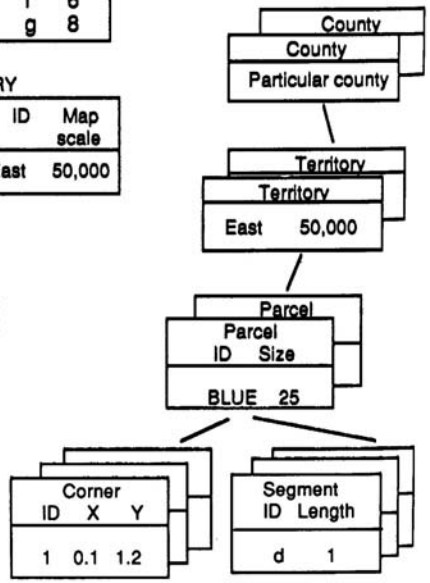
TERRITORY

Parcel	Segment	Corner
BLUE	a	1
BLUE	a	6
BLUE	b	1
BLUE	b	2
BLUE	g	2
BLUE	g	5
BLUE	f	5
BLUE	f	6
GREEN	c	2
GREEN	c	3
GREEN	d	3
GREEN	d	4
GREEN	e	4
GREEN	e	5
GREEN	g	5
GREEN	g	2

(e) "Flat file" data table

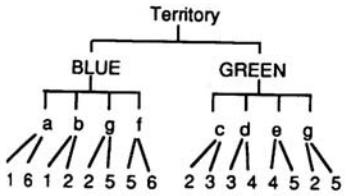


(d) Items selected from a county database

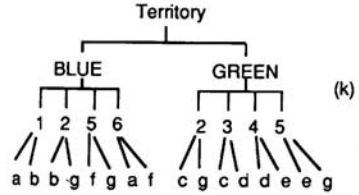


(f) Data linkages for the hierarchical model

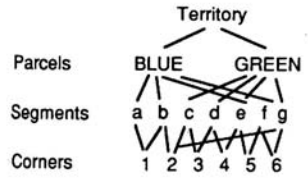
Figure 9.5 A spatial data example for hierarchical, network, and relational organization. (a) Territory. (b) Parcels, segments, and corners. (c) Tables of separate elements. (d) Selected items from a county database. (e) Flat file table. (f) Data linkages for the hierarchical model. (g) Hierarchical structure to obtain corner coordinates. (h) Hierarchical structure to obtain length of segments. (i) Complex network structure (many-to-many). (j) Data linkages for the network model (partial). (k) Data records for (part of) the network model. (l) Data tables for the relational model.



(g) Hierarchical structure to obtain the corner coordinates



(h) Hierarchical structure to obtain the length of segments



(i) Network structure

Record number	Segment -ID	Segment length	Parcel	Parcel link *
1	a	5	BLUE	2
2	b	5	BLUE	6
3	c	6	GREEN	4
4	d	1	GREEN	5
5	e	7	GREEN	8
6	f	6	BLUE	7
7	g	8	BLUE	end
8	g	8	GREEN	end

* Serves as a pointer to the next record

(k) Data records for part of the network model database

SEGMENTS DATA

Segment -ID	Length	Begin vertex	End vertex	Parcel
a	5	6	1	BLUE
b	5	1	2	BLUE
c	6	2	3	GREEN
d	1	3	4	GREEN
e	7	4	5	GREEN
f	6	5	6	BLUE
g	8	5	2	BLUE
g	8	5	2	GREEN

To get the size of the parcel that segment g is part of

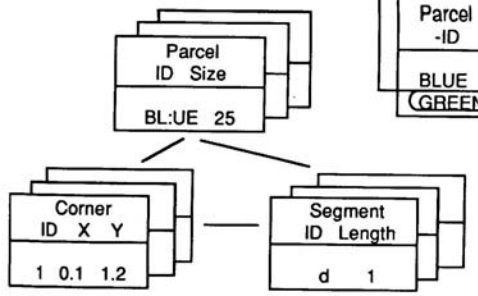
PARCELS DATA

Parcel -ID	Size
BLUE	25
GREEN	17

To get the coordinates for the end of segment d

CORNERS DATA

Vertex -ID	X	Y
1	0.1	1.2
2	1.1	1.4
3	2.0	1.3
4	2.1	1.1
5	1.0	0.0
6	0.0	0.4



(j) Data linkages for the hierarchical model

(l) Data tables for the relational model

Figure 9.5 continued

How to represent data in database

- well defined process
  - universe to be modeled is defined (subset of world) but anything that we could model
  - external models defined (subset of universe)
    - what do users want the database to deal with?
    - Often people form different foci or departments in an enterprise
  - Conceptual model
    - synthesis of all external models
      - schematic representations of how various parts of external models interrelate
      - this helps people figure out how differing elements relate, if there are overlaps, gaps etc.
      - often entity-relationship methods used (later)
  - Logical model
    - conversion of above to structures appropriate to DBMS
    - data dictionary may be essential
  - internal model - what computer actually does

Entity-relationship model

- entities
  - the things - a parcel, a house
- classes of entities
  - houses, parcels
- relationships between entities or classes of entities
  - associations - house is on a parcel
- attributes of entities and relationships
  - size of parcel, type of house
- cardinalities of relationships
  - number of linkages
    - term is degree
      - one -to - one
      - one - to -many
      - many - to -many
- integrity constraints

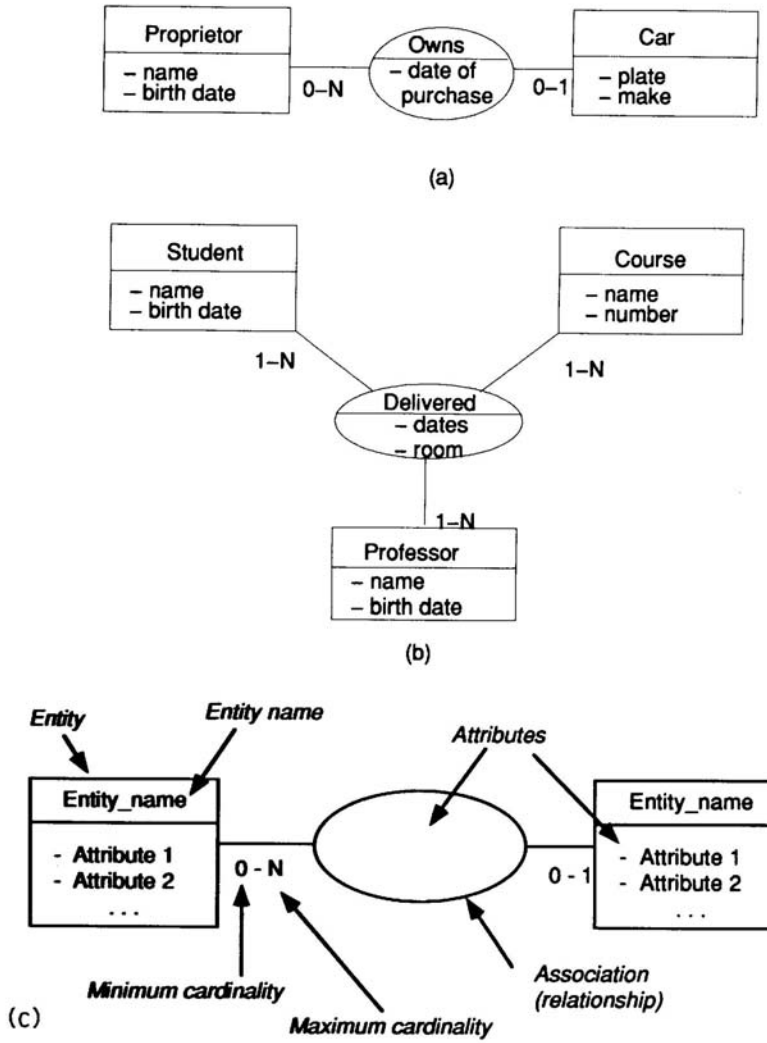


Figure 9.7 Examples of entity-relationship diagrams. (a) Example of a binary relationship. (b) Example of a ternary relationship. (c) Nomenclature for entity-relationship diagrams.

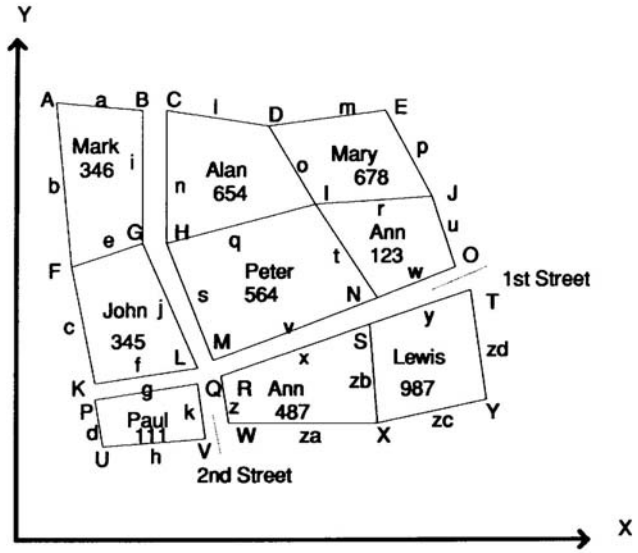


Figure 9.8 An example of land parcels: toy cadastre.

Parcels have three segments

A segment can limit two parcels
or a parcel and a street

Segments have two endpoints

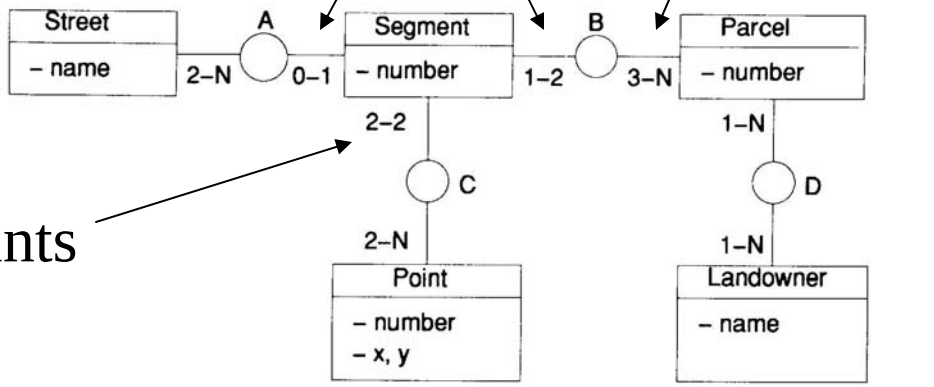


Figure 9.9 The entity-relationship diagram for land parcels. A: streets have edges (segments); B: parcels have boundaries (segments); C: line segments have two endpoints; D: parcels have owners, and people own land.

Relational databases

- Key ideas from Codd
- relation
  - organized assembly of data that meets certain conditions
  - all relations are tables but not all tables are relations
- relational database - collection of relations represented by statements as to contents and tables containing instances of the relations

Relation

- R(owner, car_make, license_number)

Owner	car_make	license_number
Smith	ford	456 SAP
Jones	toyota	WER 345
etc...		

table nomenclature
rows, cases
column
cell, data value

relational nomenclature
tuple, records
column
cell, value in domain

domain = range of acceptable values
data type = e.g. characters, date, integers

Schema

- statements that define the structure
- keys link tables together

Parcel
parcel_id, integer
parcel_name, character

Owner
last_name, char 20
first name, char 20
parcel_id, integer

Segments
segment_id, integer
parcel_id, integer

Vertices
segment_id, integer
x coordinate, float
y coordinate, float