

# 데이터 모델

Data model

# 데이터 모델



## GIS 데이터

데이터  
모델

공간  
데이터

속성  
데이터

벡터

래스터

- 기하학적 요소  
(x, y 좌표체계)
- 위상구조

- 인공위성데이터
- 항공사진데이터
- 이미지데이터

DBMS

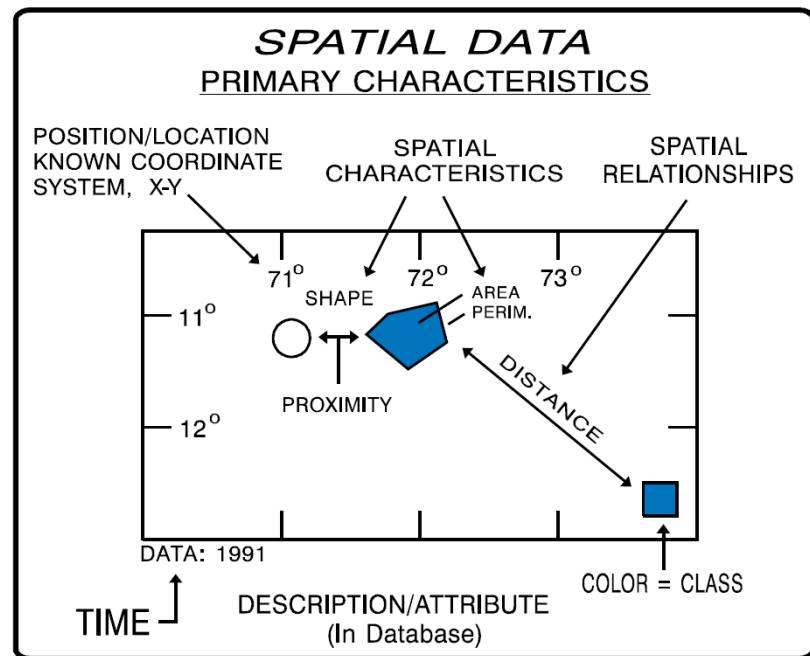
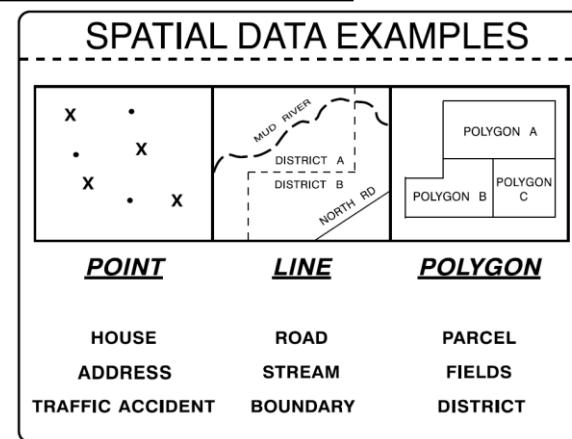
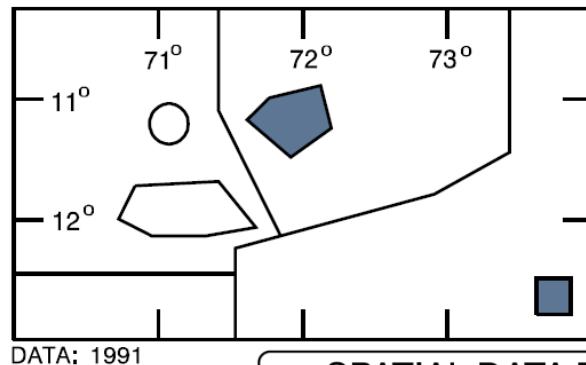
- 관계데이터모델
- 관계-객체데이터모델
- 객체지향데이터모델

# 데이터 모델



## 공간 데이터

# SPATIAL DATA



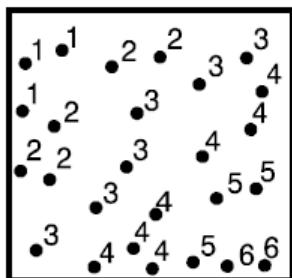
Object  
Feature

# 데이터 모델



## 데이터 VS 정보

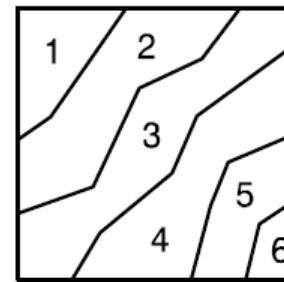
### DATA vs. INFORMATION



#### DATA

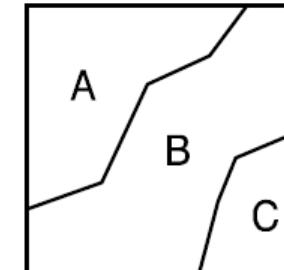
Sample sites  
Vegetation types

- 1 - Red Mangrove
- 2 - Black Mangrove
- 3 - Coconut Palm
- 4 - Ivory Nut Palm
- 5 - Lime
- 6 - Orange



#### INFORMATION AND DATA

Collective veg. types  
Area interpretation  
Vegetation zones



#### INFORMATION

Categories  
Relationships

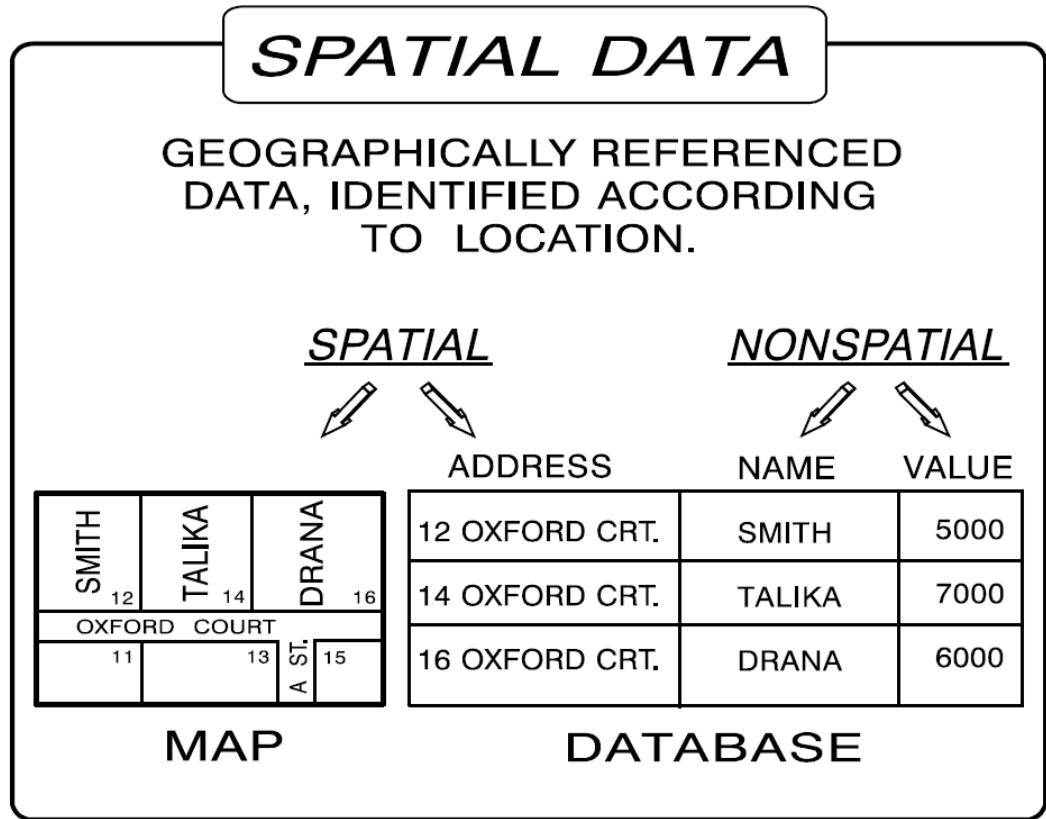
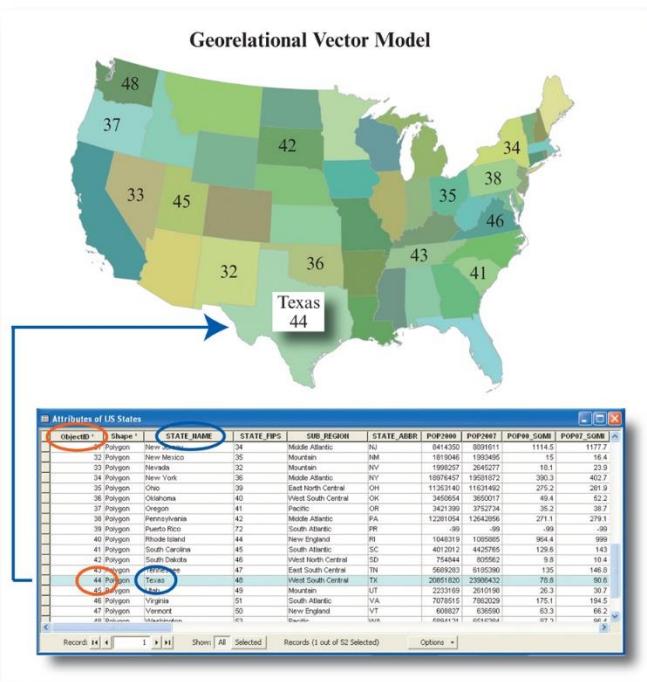
- A - Mangrove
- B - Palm
- C - Citrus

# 데이터 모델



## 공간 데이터 구분

- Spatial & Non Spatial
- Map & Database



# 데이터 모델



## 데이터베이스 (속성정보)

- 데이터가 표 형태로 저장 (관계형)
- 행 = 레코드(record)
- 열 = 필드(field)
- 정렬 / 검색 / 필터 등

### DATABASE

AREA	NAME	SIZE (SQ KM)	MAJOR CROP	POP (000)
A	DUBOP	11	RICE	1.1
B	JUMOM	22	RICE	1.7
C	TEROP	21	NONE	2.0
D	EERTO	17	RICE	0.7
E	BUROP	20	FRUIT	0.3

DATABASE: A list or table of data arranged by:  
Columns: categories of data termed "Fields"  
Rows: "Record" of each entry or observation.

### DATABASE SELECTION OPTIONS

AREA	NAME	SIZE (Ha)	MAJOR CROP	POP (000)	
A	DUBOP	11	RICE	1.1	+ 0.3 = 1.4
B	JUMOM	22	RICE	1.7	
C	TEROP	21	NONE	2.0	
D	EERTO	17	RICE	0.7	
E	BUROP	20	FRUIT	0.3	

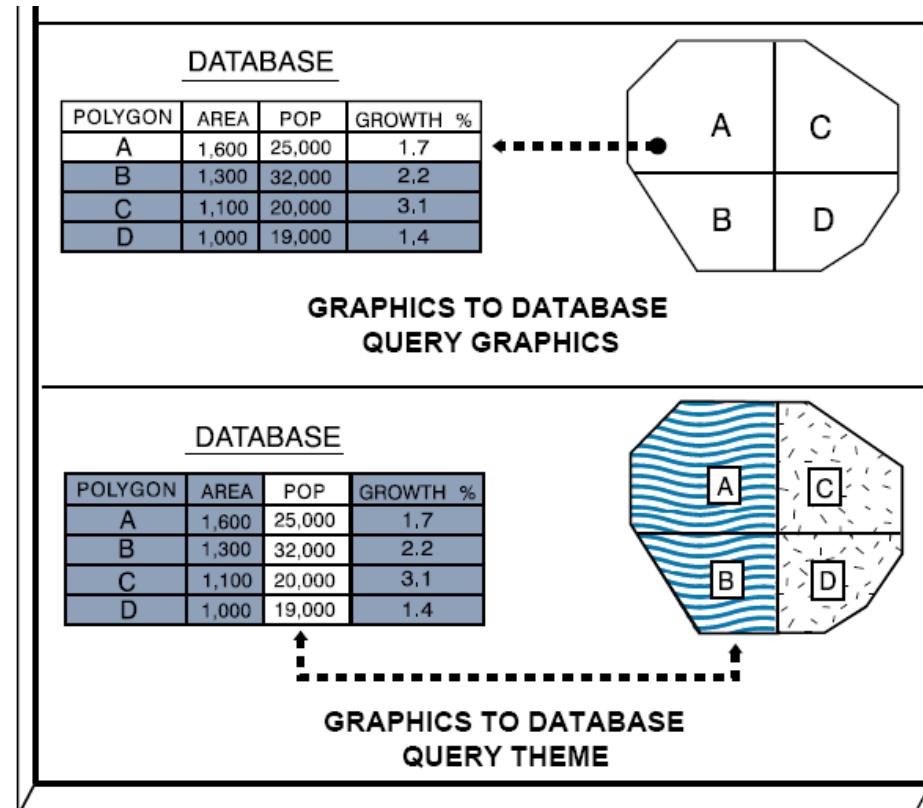
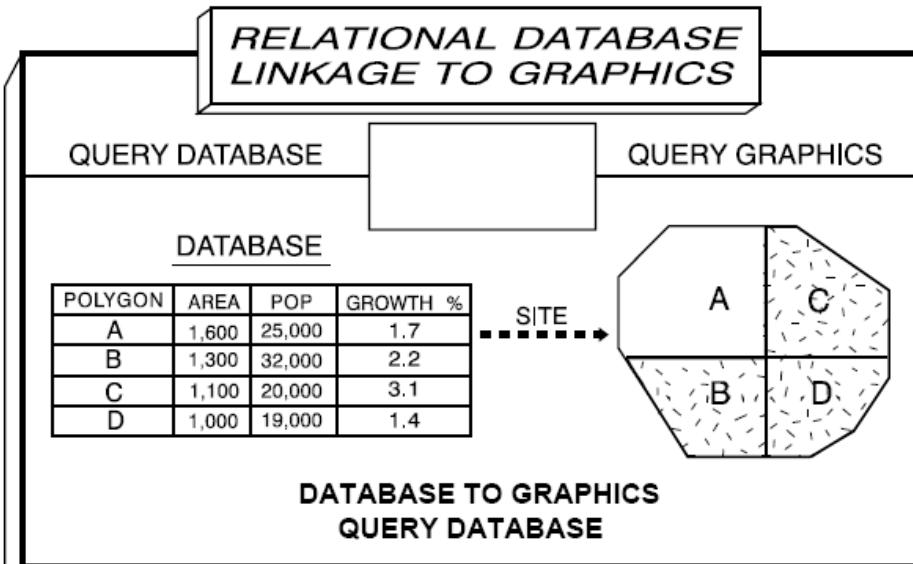
1. List selected records. **LIST B**  
List selected fields. **LIST CROPS**
2. Sort any field alphabetically or numerically. **SORT NAMES**  
Sort any field ascending or descending.
3. List by range of field data.  
**SHOW POPULATION 1,100 - 1,800**
4. Any combination of above.  
**SHOW AREAS > 18 Ha, NOT RICE, POP > 1.3**
5. Can be modified or appended.  
**MODIFY: ADD 0.3 TO AREA A POP**

# 데이터 모델



## 데이터베이스(속성정보)와 공간 연계

- 해당 ID 체계를 통해 공간 데이터와 연계
- 연계하여 쿼리(검색) 가능



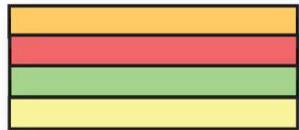
# 데이터 모델



## 데이터베이스 모델

### Database Relationships

Database 1



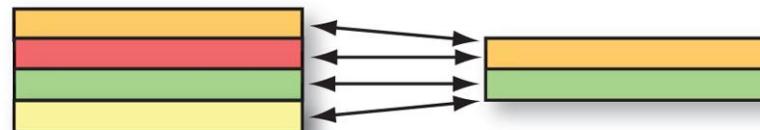
Database 2



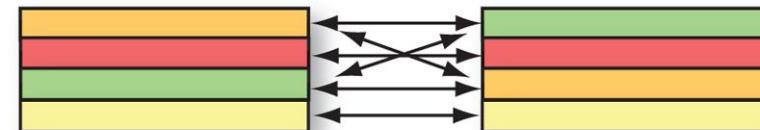
a. One-to-one.



b. One-to-many.



c. Many-to-one.



d. Many-to-many.

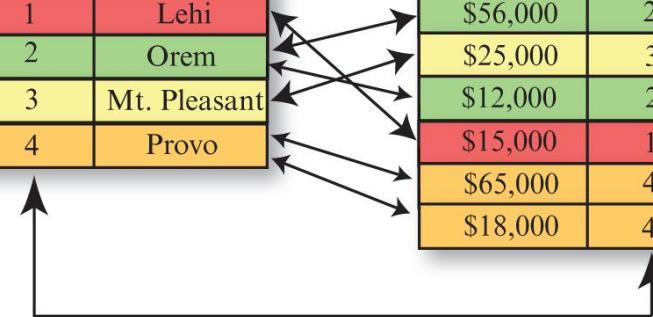
### One-to-Many Relationship

City Boundary  
Geodatabase

City_ID	City Name
1	Lehi
2	Orem
3	Mt. Pleasant
4	Provo

Road Expenditure  
Database

Expenditure	City_ID
\$56,000	2
\$25,000	3
\$12,000	2
\$15,000	1
\$65,000	4
\$18,000	4



© 2013 Pearson Education, Inc.



## 공간 속성 Many to One Relationship

### Many-to-One Relationship

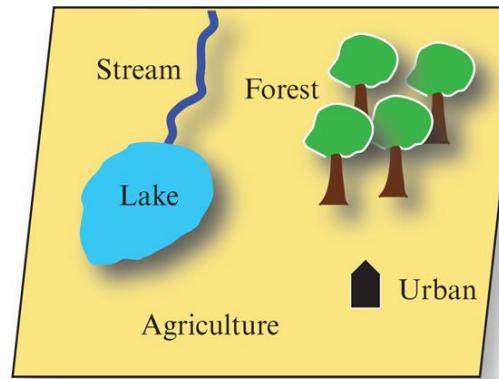
Attributes of albuq						Attributes of USGS land cover classes			
FID	Shape	AREA	PERIMETER	ALBUQ_	LUCODE	OID	Field1	USGS_Code	Description
0	Polygon	0.311621	2.24669	2	0	0	0	11	Open Water
1	Polygon	0.188074	1.75222	3	0	1	0	12	Perennial Ice/Snow
2	Polygon	0.000061	0.041268	4	42	2	0	21	Low Intensity Residential
3	Polygon	0.000704	0.246474	5	32	3	0	22	High Intensity Residential
4	Polygon	0.00226	0.488938	6	42	4	0	23	Commercial/Industrial/Transportation
5	Polygon	0.000039	0.033431	7	33	5	0	31	Bare Rock/Sand/Clay
6	Polygon	0.00004	0.035351	8	17	6	0	32	Quarries/Strip Mines/Gravel Pits
7	Polygon	0.000161	0.081516	9	75	7	0	33	Transitional
8	Polygon	0.022371	2.926913	10	42	8	0	42	Evergreen Forest
9	Polygon	0.273339	9.766444	11	42	9	0	41	Deciduous Forest
10	Polygon	0.000039	0.045517	12	11	10	0	43	Mixed Forest
11	Polygon	0.000296	0.082581	13	43	11	0	51	Shrubland
12	Polygon	0.000307	0.107915	14	43	12	0	61	Orchards/Vineyards/Other
13	Polygon	0.01475	1.229476	15	43	13	0	71	Grasslands/Herbaceous
14	Polygon	0.000073	0.045263	16	41	14	0	81	Pasture/Hay
15	Polygon	0.000272	0.10668	17	33	15	0	82	Row Crops
16	Polygon	0.000063	0.033735	18	33	16	0	83	Small Grains
17	Polygon	0.000303	0.108705	19	33	17	0	84	Fallow
18	Polygon	0.000049	0.035184	20	11	18	0	85	Urban/Recreational Grasses
19	Polygon	0.000108	0.049516	21	12	19	0	91	Woody Wetlands
20	Polygon	0.000011	0.01627	22	21				

# 데이터 모델

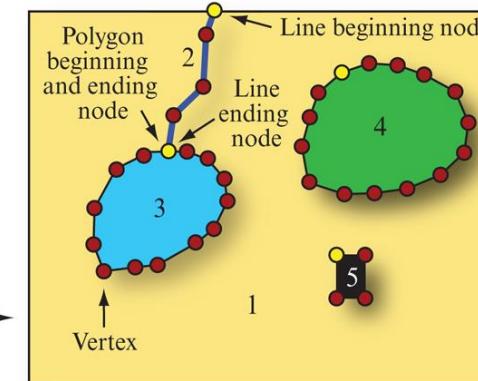


## 벡터 데이터와 래스터 데이터 모델

Vector and  
Raster Data Models



a. Real world.



b. Vector data model.

1	1	1	1	1	2	1	1	1	1	1	1	1
1	1	1	1	1	2	1	1	1	1	1	1	1
1	1	1	1	2	2	1	1	4	4	4	4	1
1	1	1	2	1	1	4	4	4	4	4	4	1
1	1	3	3	3	3	1	4	4	4	4	4	1
1	3	3	3	3	3	1	1	4	4	4	1	1
1	3	3	3	3	3	1	1	1	1	1	1	1
1	1	3	3	3	1	1	1	5	1	1	1	1
1	1	1	1	1	1	1	1	5	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1

c. Raster data model.

Point  
Line  
Polygon

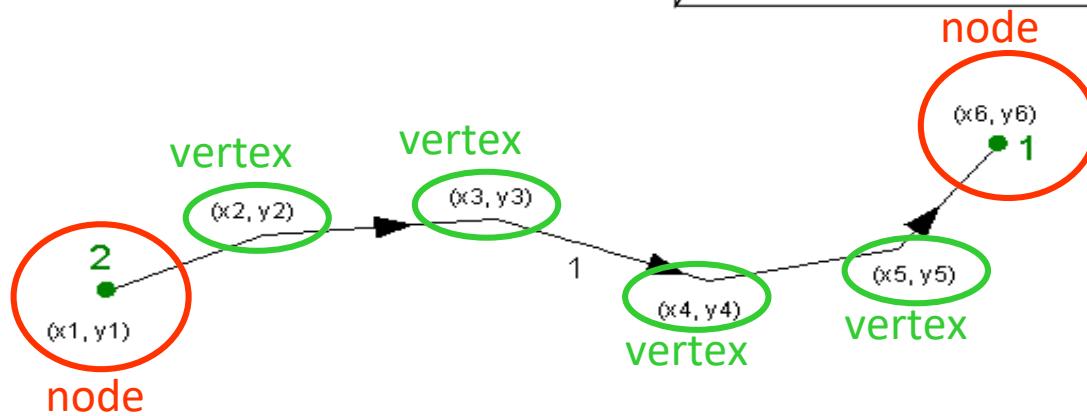
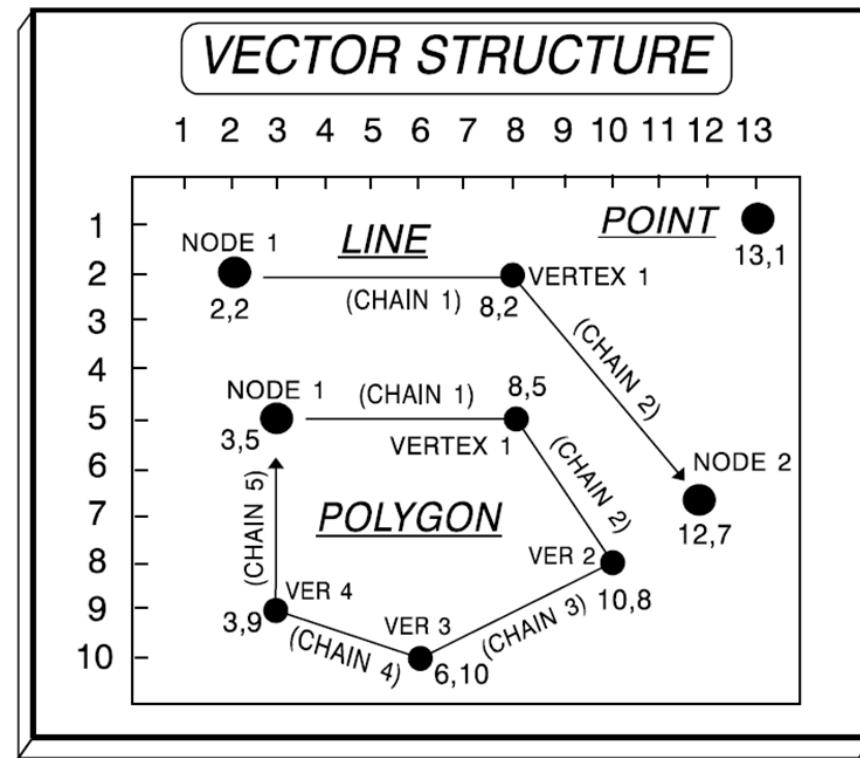
Pixel

# 데이터 모델



## 벡터 데이터 구조

- Node
- Vertex
- Line
- Chain = Arc
- Line segment
- Line string

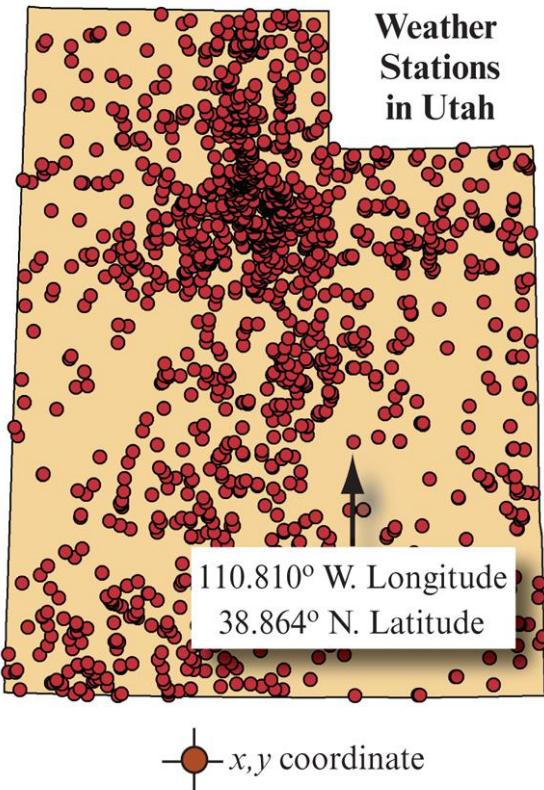


# 데이터 모델



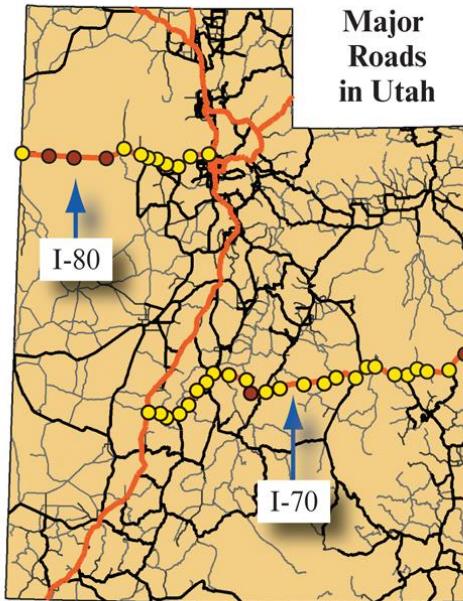
# 벡터 데이터 탑입

## Points

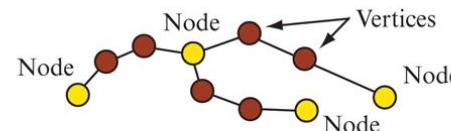


## Lines

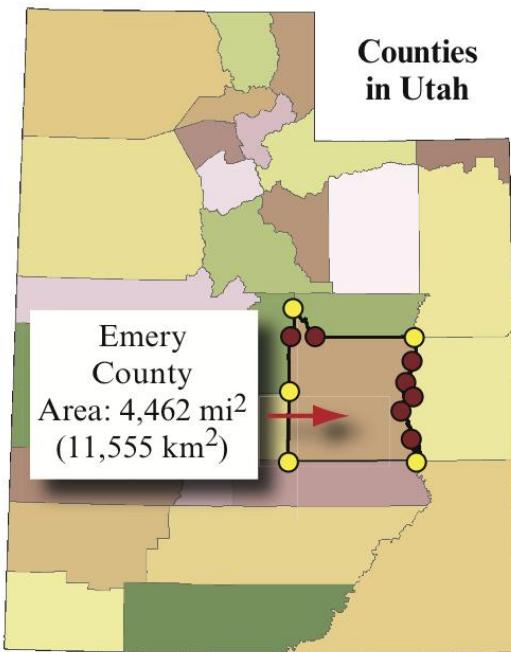
## **Major Roads in Utah**



Nodes begin and end lines and are also located at the intersection of two or more lines. Vertices define the line between nodes.



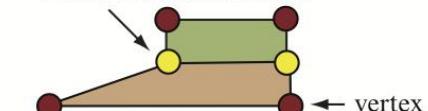
## Areas (Polygons)



A single node defines the beginning and end of a stand-alone polygon.



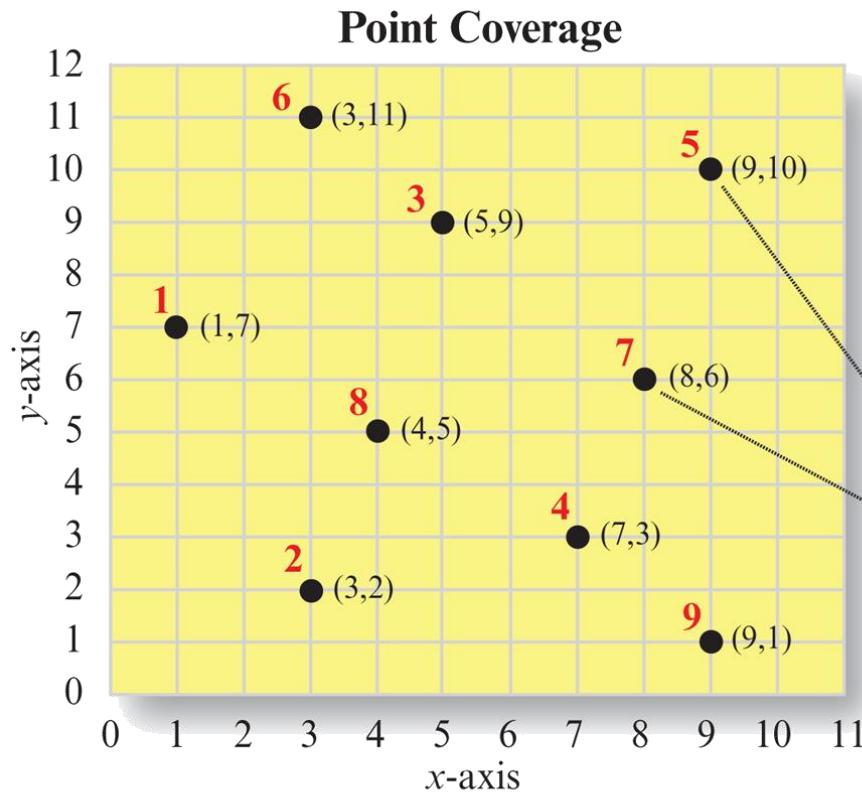
Polygons that share common boundaries share nodes.





## 벡터 데이터(Point)

- Layer / Coverage

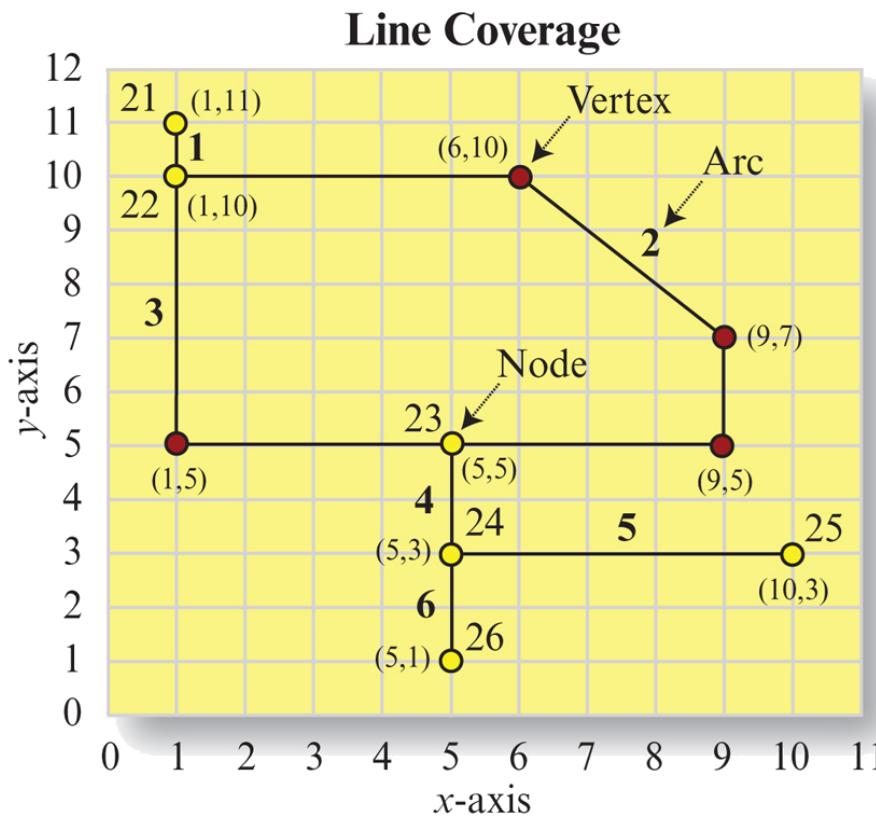


# 데이터 모델



## 벡터 데이터(Line)

### - Fnode Tnode



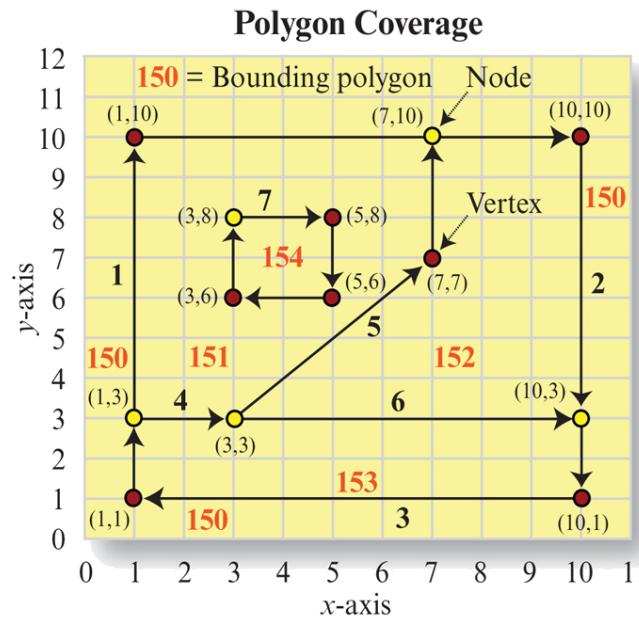
Arc Nodes		
Arc	From node	To node
1	21	22
2	22	23
3	23	22
4	23	24
5	24	25
6	24	26

Arc Coordinates	
Arc	x,y Coordinates
1	(1,11) (1,10)
2	(1,10) (6,10) (9,7) (9,5) (5,5)
3	(5,5) (1,5) (1,10)
4	(5,5) (5,3)
5	(5,3) (10,3)
6	(5,3) (5,1)



## 벡터 데이터(Polygon)

- Shapefile
- Exchange file format



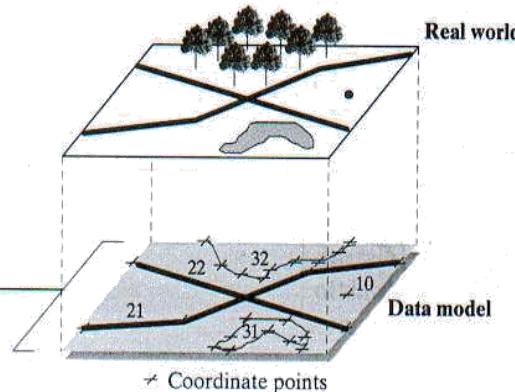
Left-Right Polygons		
Arc	Left Polygon	Right Polygon
1	150	151
2	150	152
3	150	153
4	151	153
5	151	152
6	152	153
7	151	154

Polygon Arcs	
Polygon	Arc
151	1,4,5, <b>0,7</b>
152	5,2,6
153	6,3,4
154	7

Arc Coordinates	
Arc	x,y Coordinates
1	(1,3) (1,10) (7,10)
2	(7,10) (10,10) (10,3)
3	(10,3) (10,1) (1,1) (1,3)
4	(1,3) (3,3)
5	(3,3) (7,7) (7,10)
6	(3,3) (10,3)
7	(3,8) (5,8) (5,6) (3,6) (3,8)



## 스파게티 데이터 모델



Stored data

Feature ID	Feature Type	Location
10	Point	xy
21	Line	$x_1y_1, x_2y_2, x_3y_3 \dots x_ny_n$ (string)
22	Line	$x_1y_1, x_2y_2, x_3y_3 \dots x_ny_n$ (string)
31	Polygon	$x_1y_1, x_2y_2, x_3y_3 \dots x_1y_1$ (closed loop)
32	Polygon	$x_1y_1, x_2y_2, x_3y_3 \dots x_1y_1$ (closed loop)

- 구조화 되어있지 않은 그래픽 모형
- 객체가 단순히 일련의 x, y좌표에 의한 그래픽 형태로 저장(점, 선, 면적)
- 객체들간의 공간 관계에 대한 정보 x
- 인접 다각형의 경계 변은 두 번씩 중복 저장
- 객체들의 공간 관계가 없으므로 계산에 의해 정보를 생성해야하므로 분석시 비효율적
- 매우 간단하고 이해하기 쉬움
- 위상구조가 없기 때문에 간단한 수치지도를 제작하고 간접하는 경우 오히려 효과적

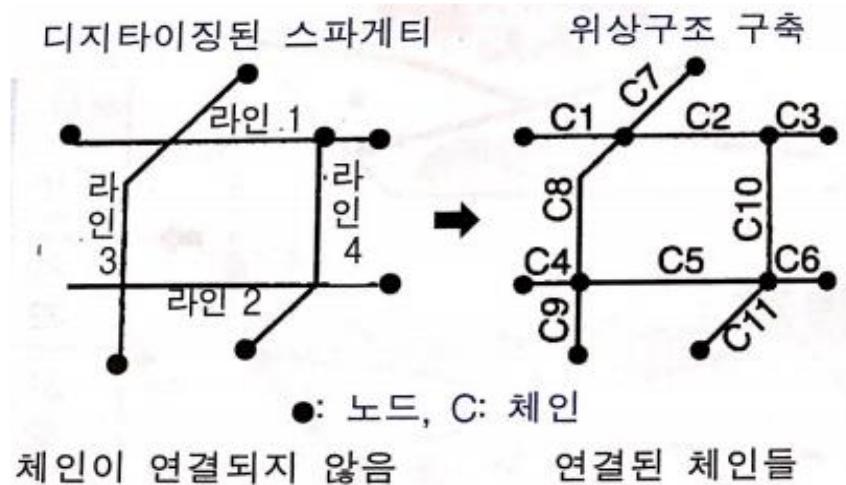
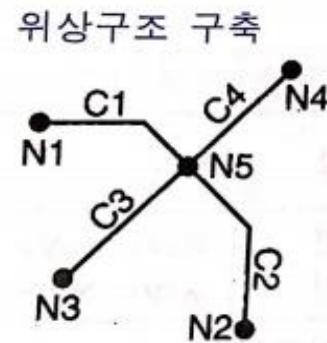
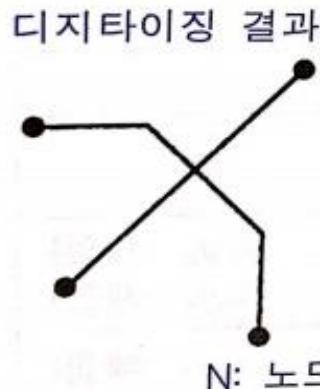
FIGURE 3.20  
The Spaghetti Data Model. The Spaghetti Data Model stores geographic data in the form of graphical elements (point, line, and polygon), but not as individually identifiable graphical entities such as a lake, a wooded area, or a highway.

# 데이터 모델



## 위상 구조 (토폴로지 자료구조)

- 객체들간 공간 관계를 파악
- 선과 선이 만나는 교차점에 노드가 형성
- 노드와 선에 대해서는 체인으로 고유 아이디 생성
- 다양한 공간 분석 기능을 수행할 수 있음
- 하지만, 많은 속성 테이블이 생성되며, 데이터가 갱신 될 때마다 위상 구조가 바뀌므로 많은 시간 소요. 그렇기 때문에 일반적인 수치 지도를 제작할 때에는 이로 구축하는 것이 비 효율적일 수 있음

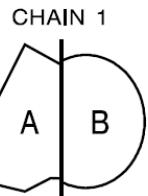


# 데이터 모델



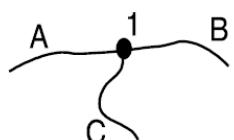
## 위상 구조 (토폴로지 자료구조)

### TOPOLOGY SPATIAL RELATIONSHIPS



LEFT POLY = A

RIGHT POLY = B



NODE 1 = CHAINS A, B, C  
CHAIN A IS CONNECTED  
TO CHAINS B and C

POLY B CONTAINED  
WITHIN POLY A

#### ADJACENCY

인접

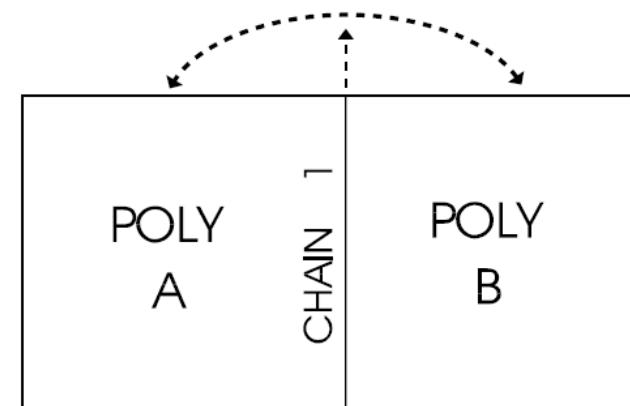
#### CONNECTIVITY

연결

#### CONTAINMENT

포함

CHAIN 1 RELATED TO POLYS A - B



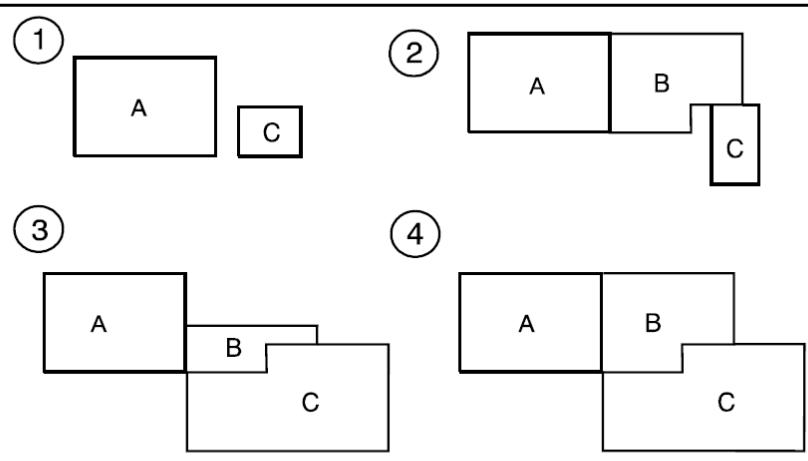
POLY A RELATED TO POLY B

# 데이터 모델



## 위상 구조 (토폴로지 자료구조)

### TOPOLOGY AND RELATIONAL QUERY



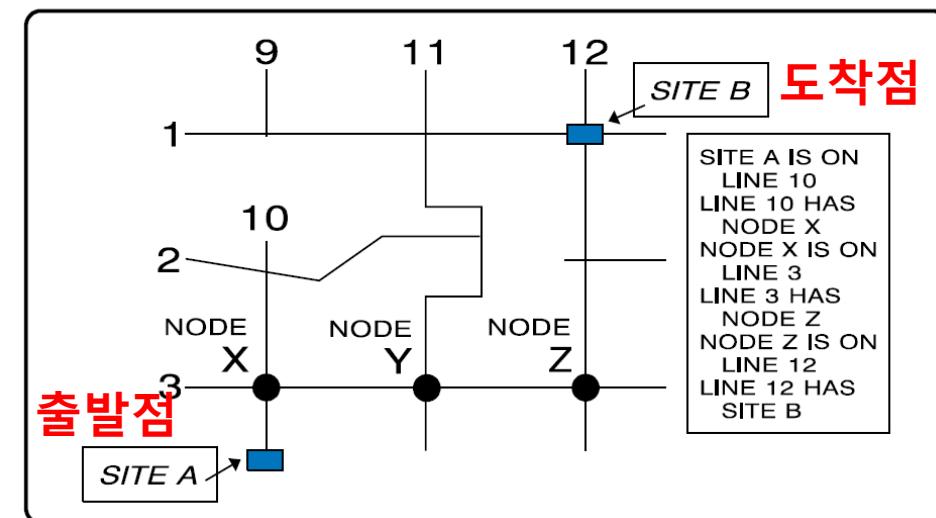
QUERY: SHOW ALL A POLYGONS THAT HAVE LARGE B POLYGONS AND LARGE C POLYGONS ATTACHED

ANSWER  
ONLY #4

### TOPOLOGY

### MULTIPLE CONNECTIVITY

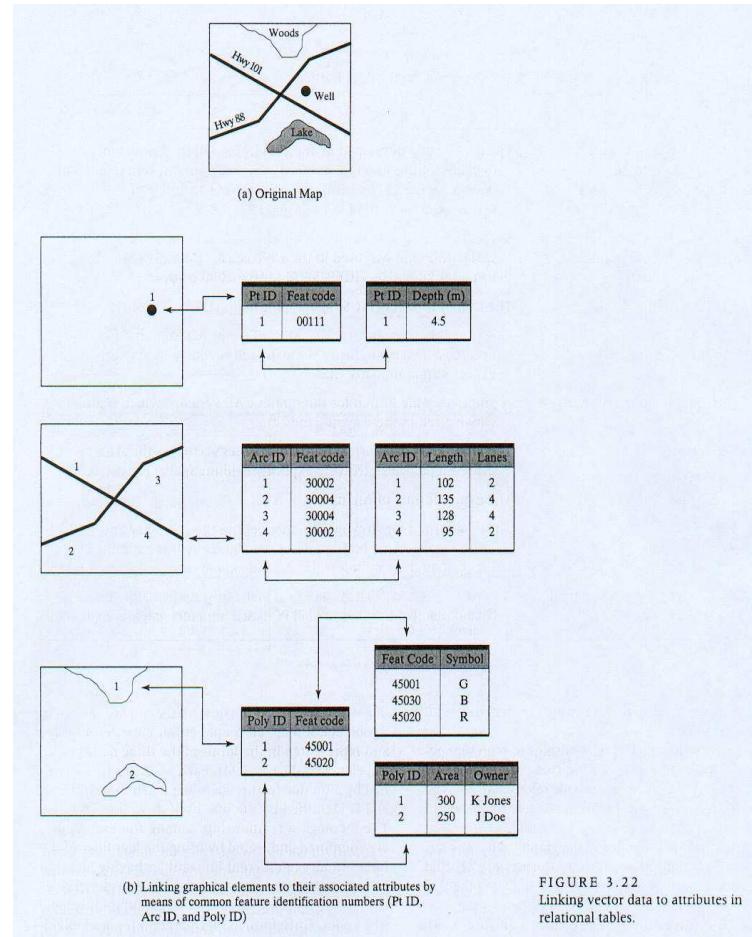
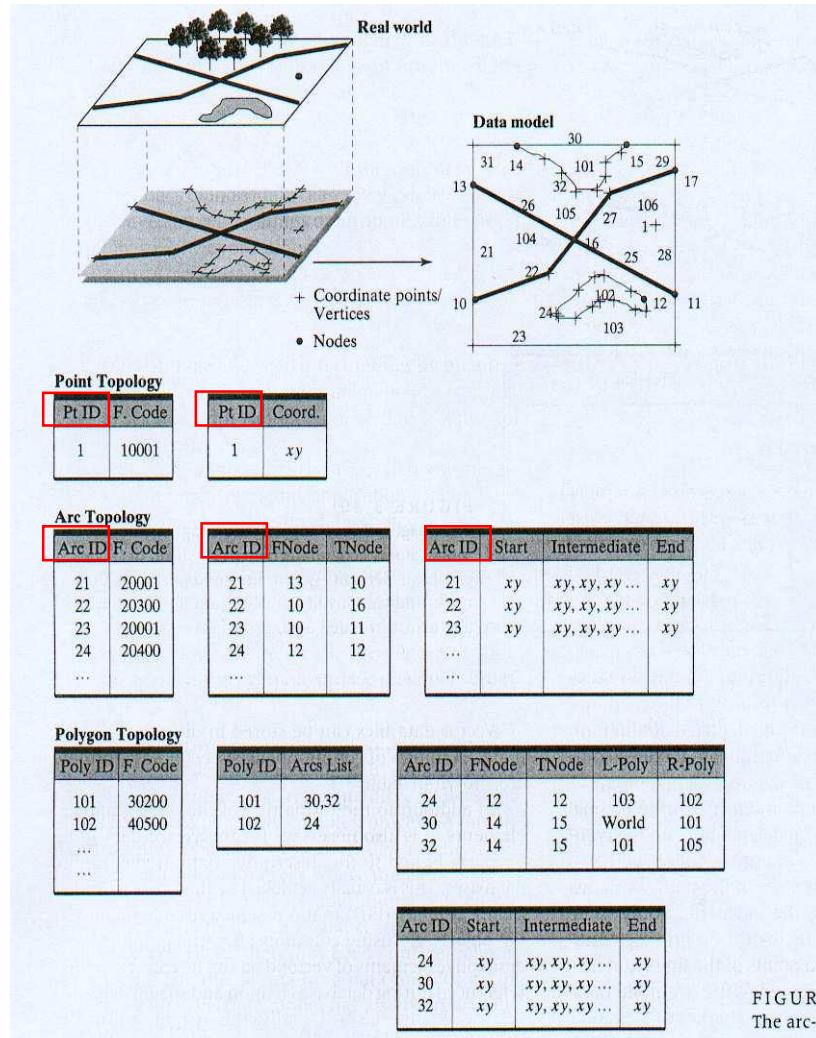
SITE A IS CONNECTED TO SITE B VIA MULTIPLE NODES AND LINES



# 데이터 모델



## 위상 구조 (토폴로지 자료구조)



# 데이터 모델



## 래스터 / 벡터 모델

### RASTER AND VECTOR FORMAT

#### RASTER

GRIDDED, GENERALIZED  
REALITY

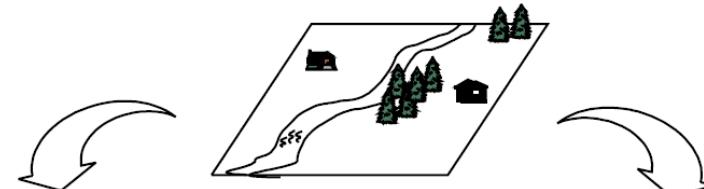
0	0	1	1	1	1	1	0	0
0	1	1	1	1	1	0	0	0
1	1	1	1	1	1	1	1	1
0	1	1	2	2	1	1	0	0
0	0	0	2	2	1	1	0	0
0	0	0	1	1	1	1	1	1
0	0	0	0	1	1	0	0	0

#### VECTOR

CARTOGRAPHIC  
MAP ANALOG



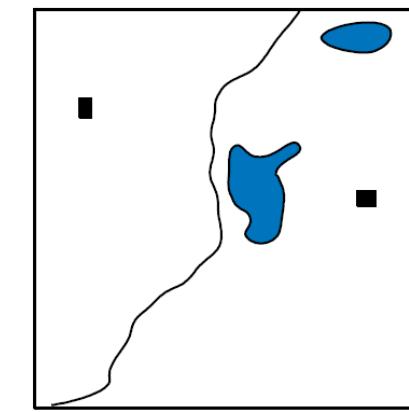
### RASTER AND VECTOR DATA MODELS



REAL WORLD

1	2	3	4	5	6	7	8	9	10
					R	T	T		
				R	R				
H				R					
			R	T	T				
			R	T				H	
			R	T					
		R							
	R								
R	R								

RASTER GRID



VECTOR

# 데이터 모델

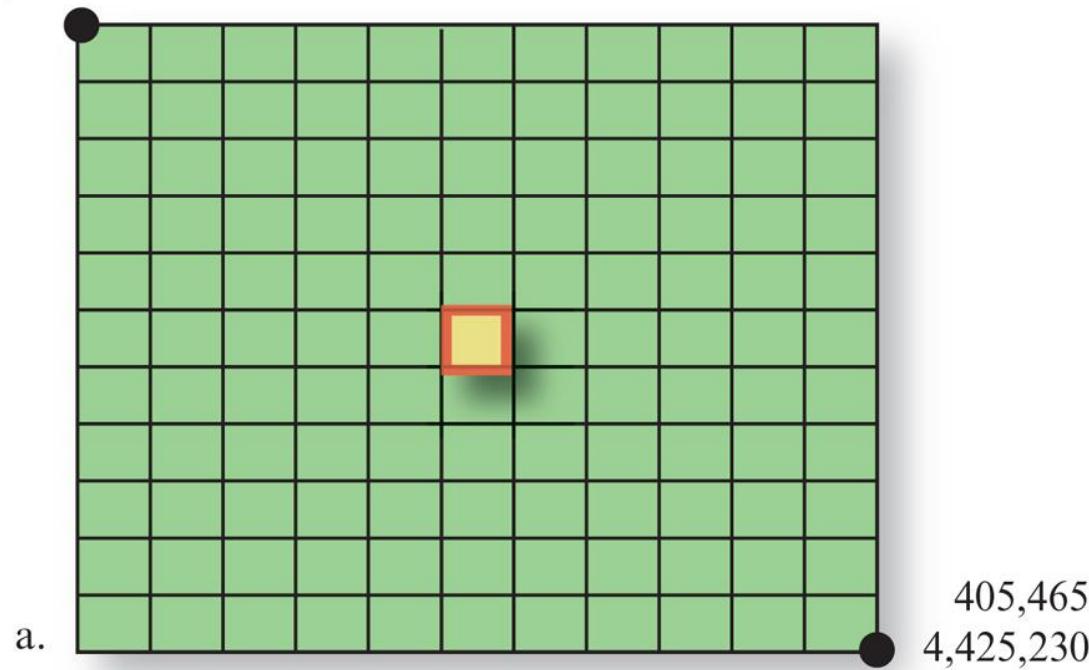


## 래스터 모델

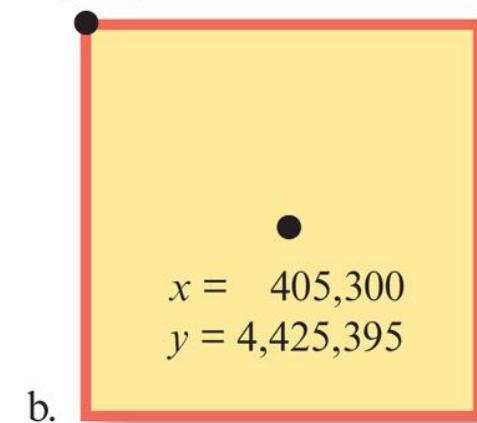
### 지구좌표입력

405,135  
4,425,560

### Raster Georeferencing



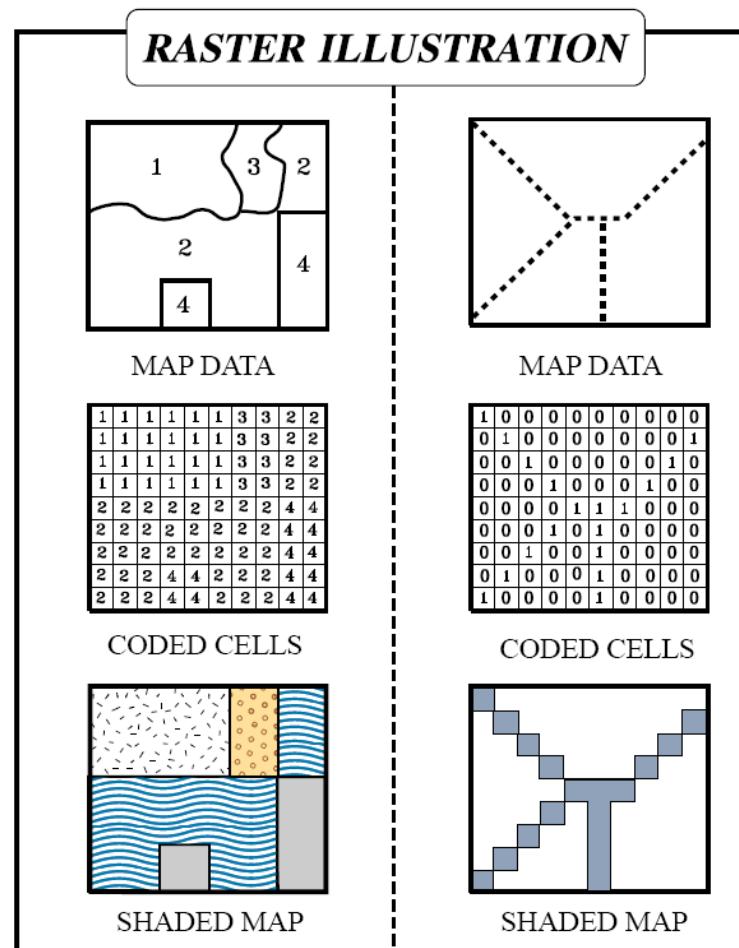
$x = 405,285$   
 $y = 4,425,410$



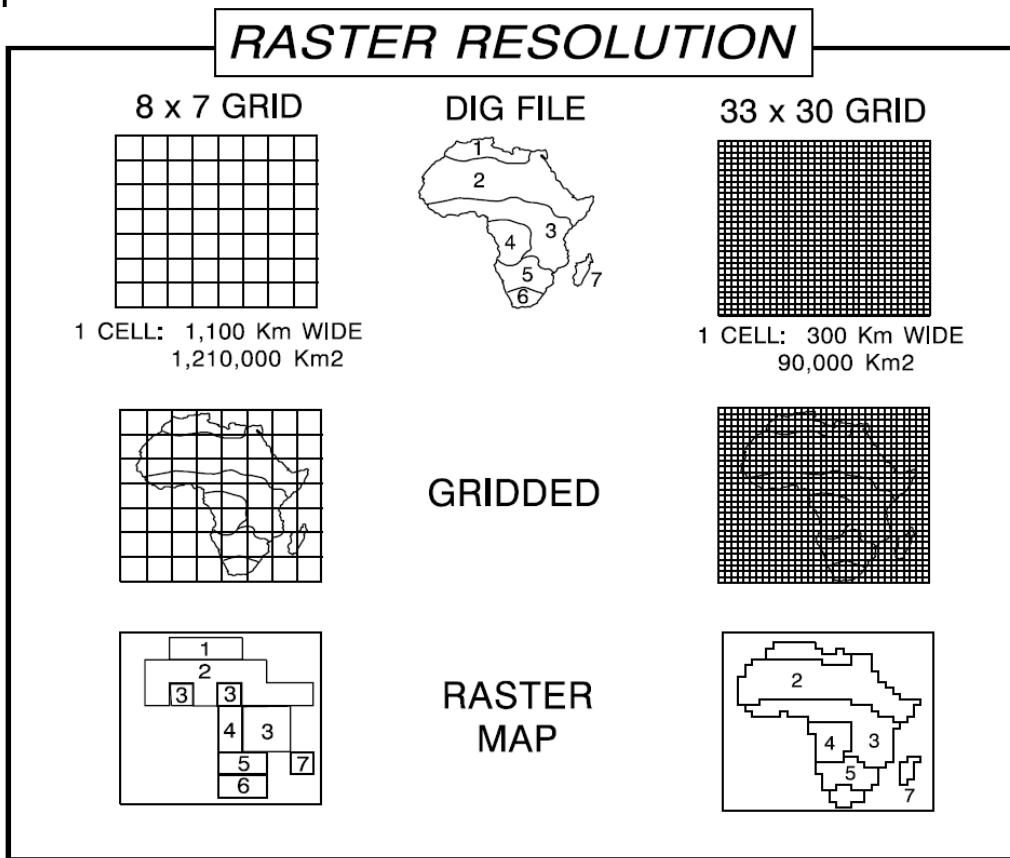
# 데이터 모델



## 래스터 모델



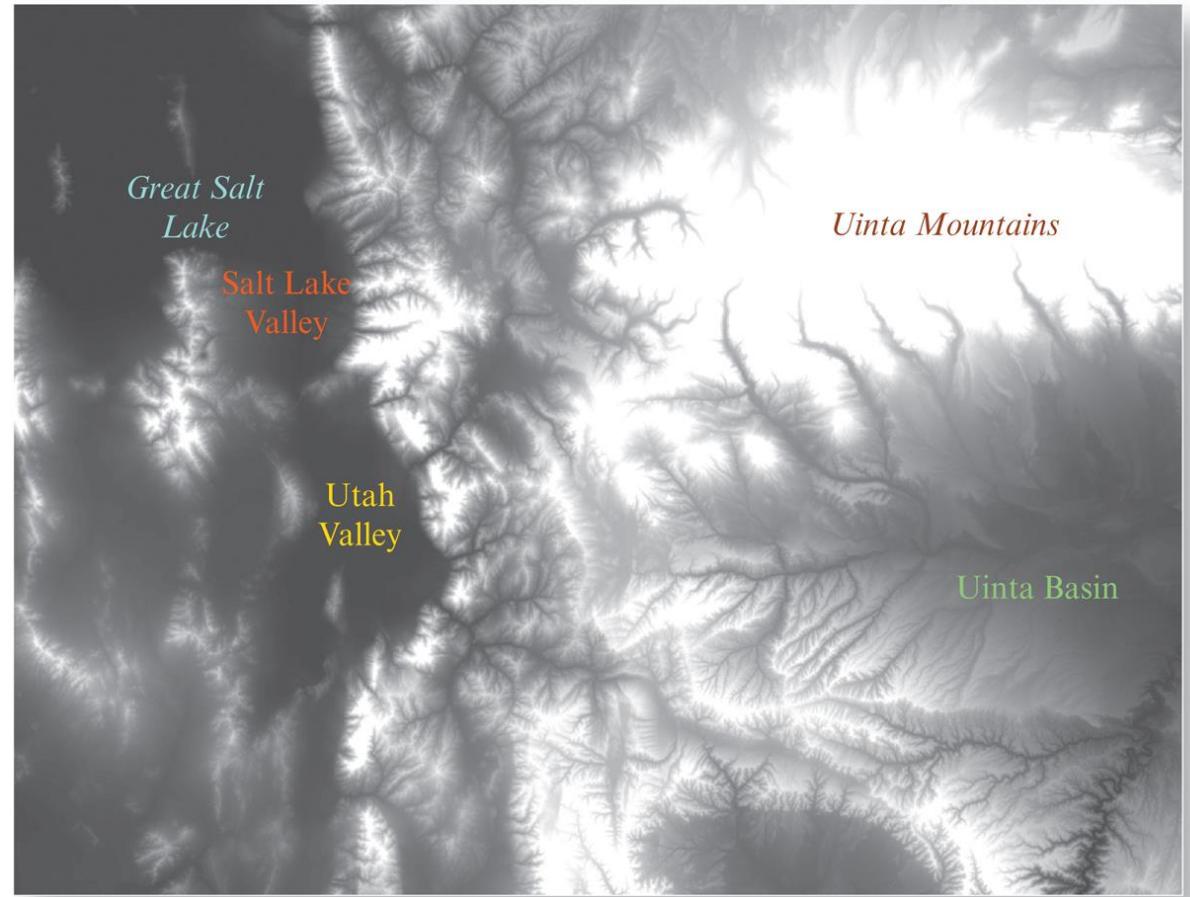
Grid 격자 = Cell 셀 (= Pixel)





## 래스터 모델

Raster Digital Elevation Model



# 데이터 모델



## 래스터 / 벡터 데이터 구조 차이

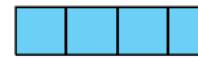
### DATA STRUCTURE

#### RASTER

POINT



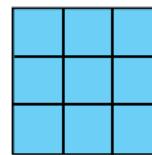
SIMPLE LINE



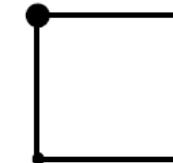
COMPLEX LINE  
(String)



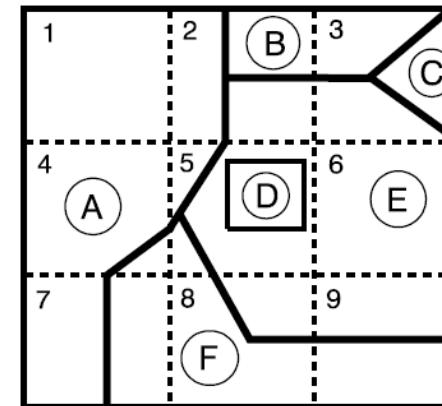
POLYGON  
(ENCLOSED AREA)



#### VECTOR



### RASTER CODING PROBLEMS

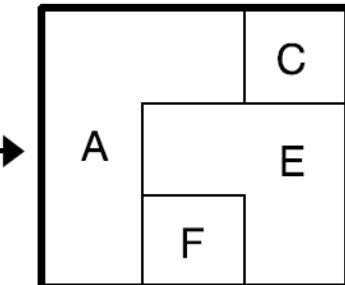
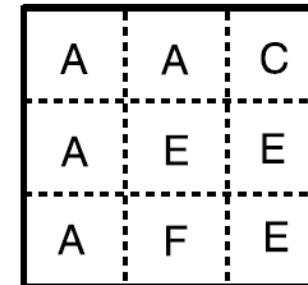


#### CODING

##### RASTER

- 1 CLEARLY CLASS A
- 2 MORE A THAN B,E; BUT < 50%
- 3 B, C, OR E ?
- 4 CLEARLY A
- 5 WHAT ABOUT D ?
- 6 CLEARLY E
- 7 55% A
- 8 MOSTLY F
- 9 50% E AND F

RESULTS: SPATIAL AND CLASSIFICATION INACCURACIES

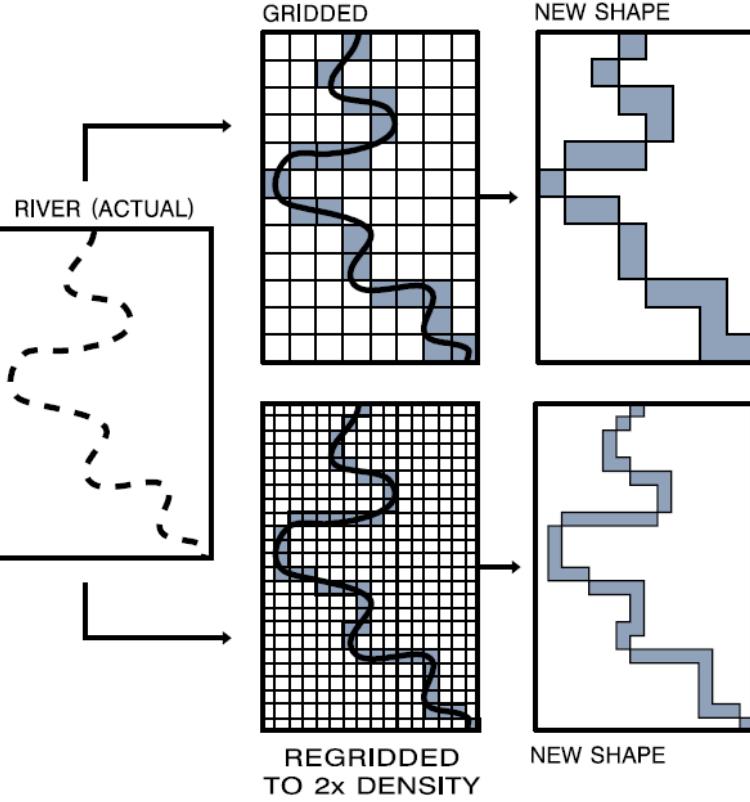


# 데이터 모델



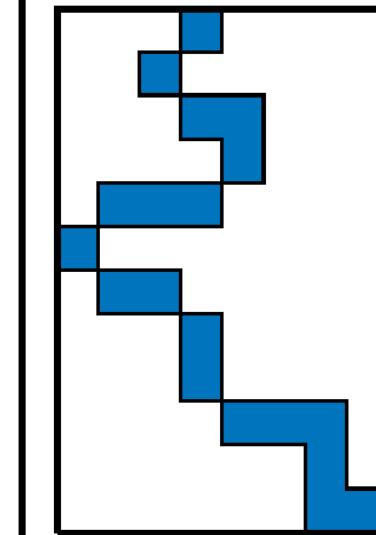
## 래스터 / 벡터 데이터 간 변환

### RASTER GRIDDING LINEAR FEATURES

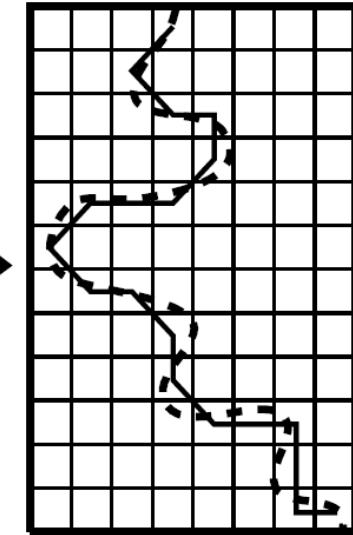


### RASTER TO VECTOR

#### RASTERIZED RIVER



#### VECTORIZED

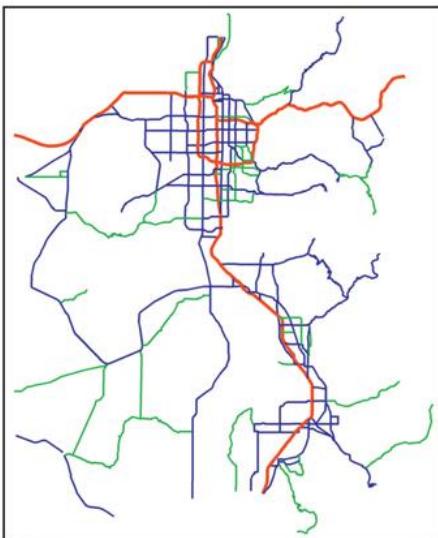


NEW VECTORED RIVER —  
ORIGINAL RIVER - - -

# 데이터 모델



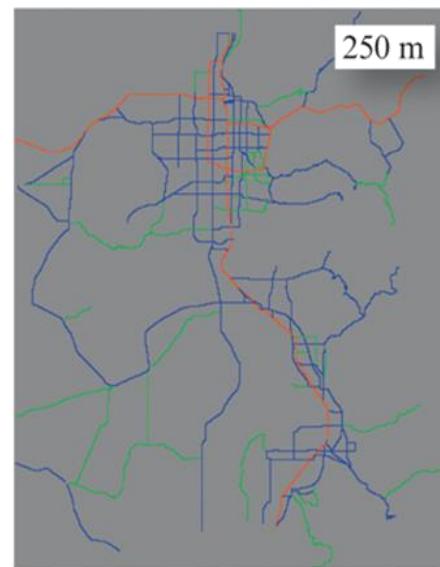
## 래스터 / 벡터 데이터 간 변환



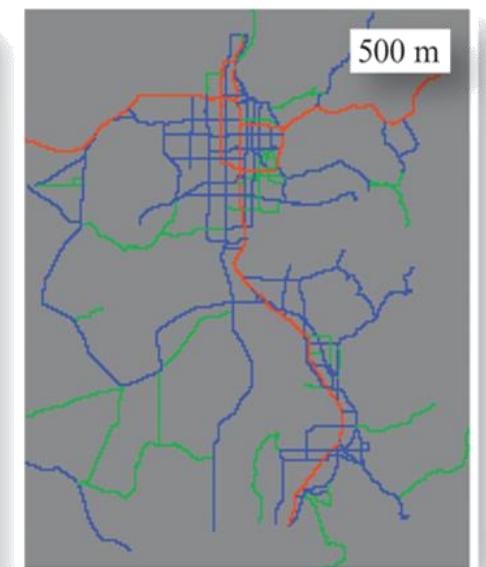
a. Vector road network information.

### Vector-to-Raster Conversion

- Interstate highway
- State highway
- Paved local road



b. Vector-to-raster conversion with a pixel size of  $250 \times 250$  m.

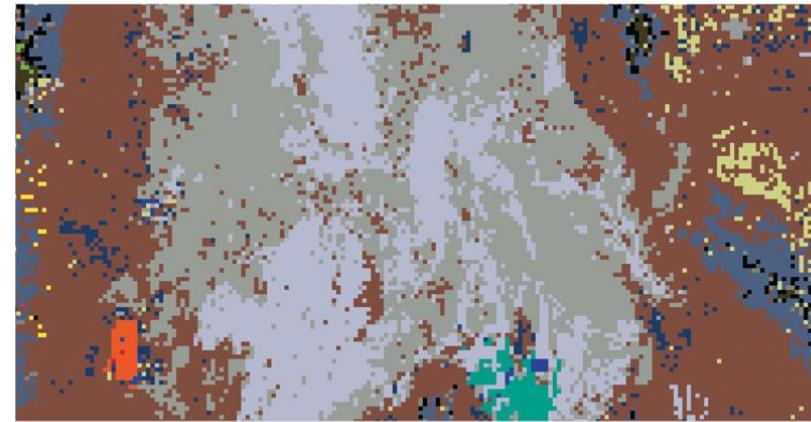


c. Vector-to-raster conversion with a pixel size of  $500 \times 500$  m.

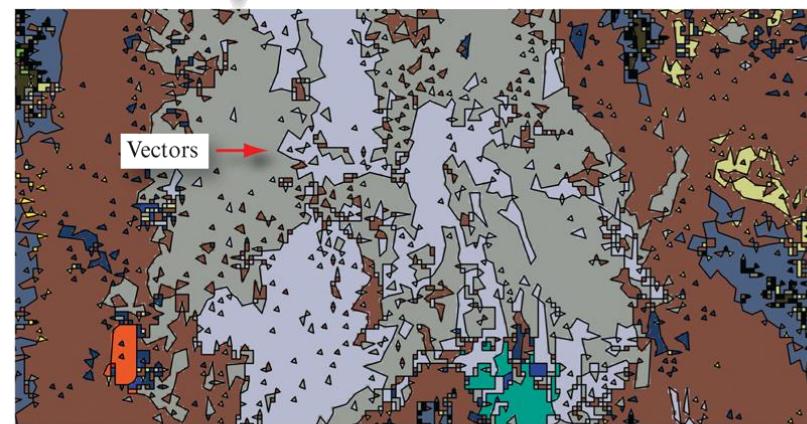


## 래스터 / 벡터 데이터 간 변환

Raster-to-Vector Conversion



a. Raster Utah GAP program data.



b. Vectorized Utah GAP program data.

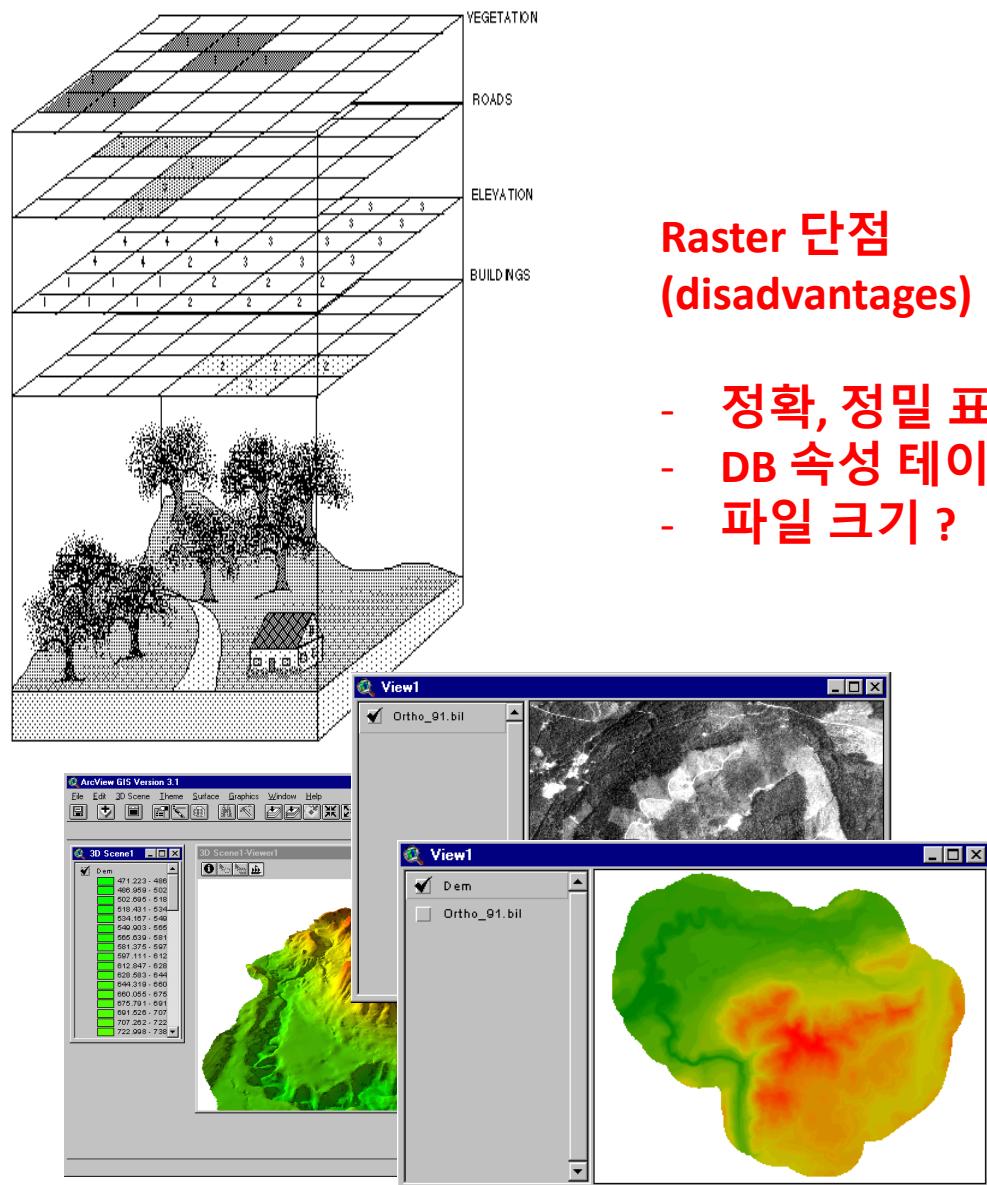
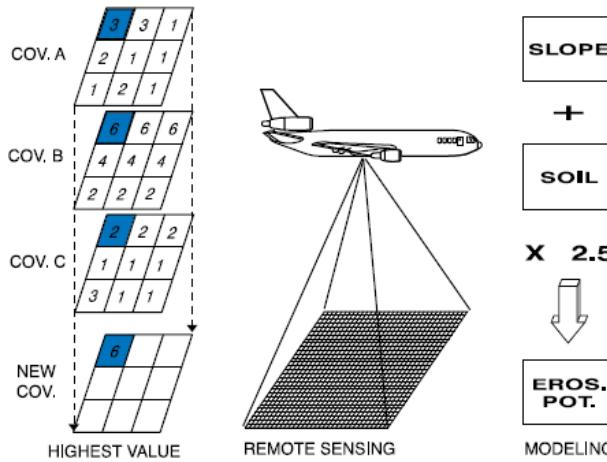
# 데이터 모델



## 래스터 장점? 단점?

### **RASTER ADVANTAGES**

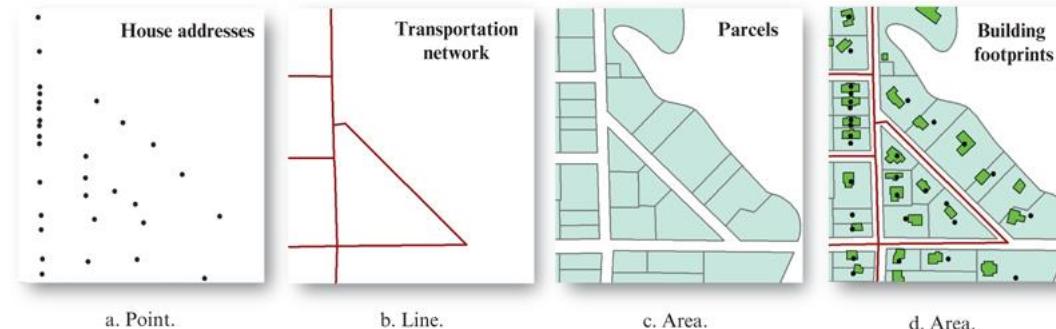
- SIMPLE DATA STRUCTURE
  - EASY ANALYSIS
  - LOW-TECH HARDWARE
- COMPATIBLE WITH IMAGERY
  - EASY MODELING



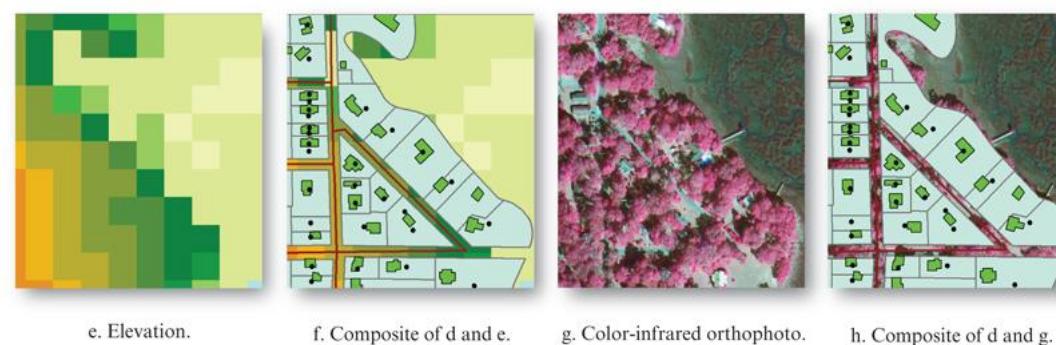
**Raster 단점  
(disadvantages)**

- 정확, 정밀 표현 ?
- DB 속성 테이블 ?
- 파일 크기 ?

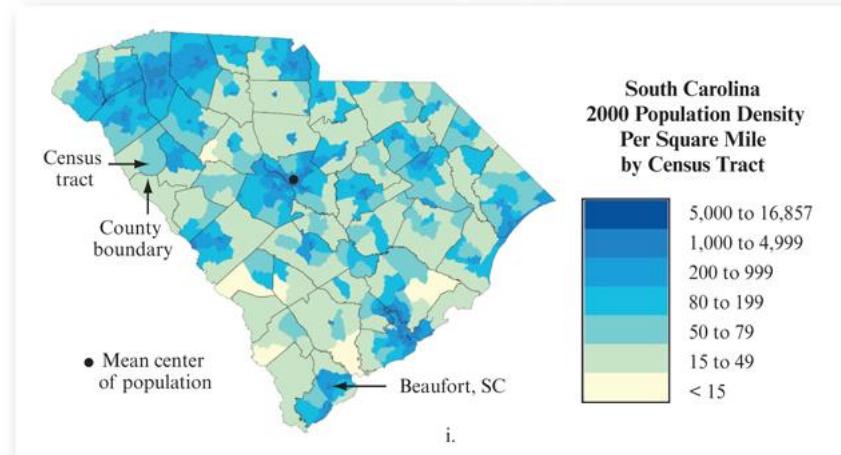
### Point, Line, and Area Discrete Features



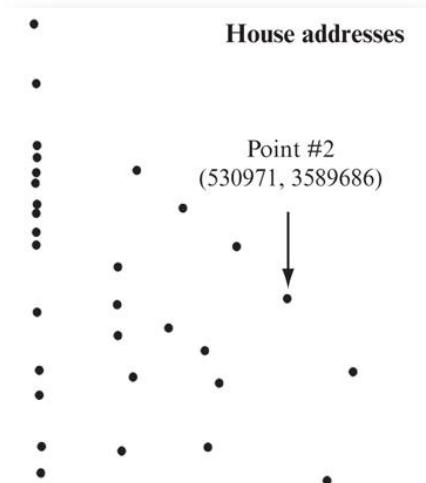
### Continuous Geographic Features



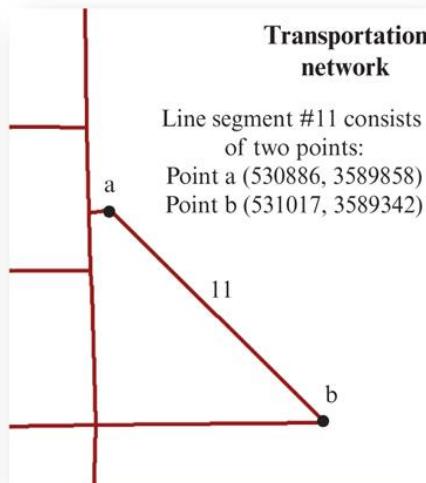
### Features Summarized by Geographic Area



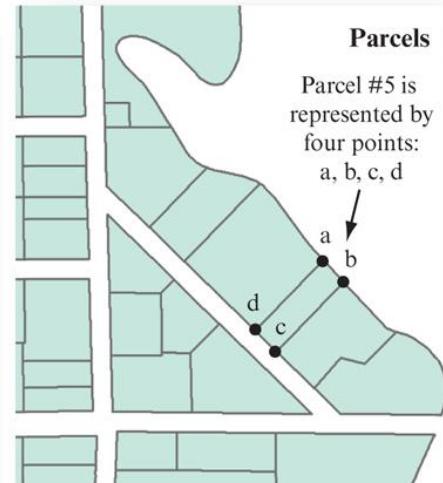
## Vector versus Raster Data Structures (Topology)



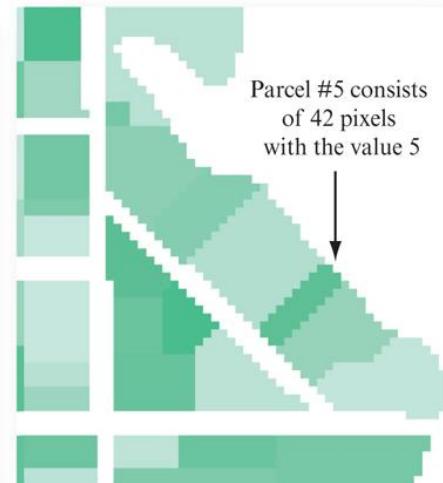
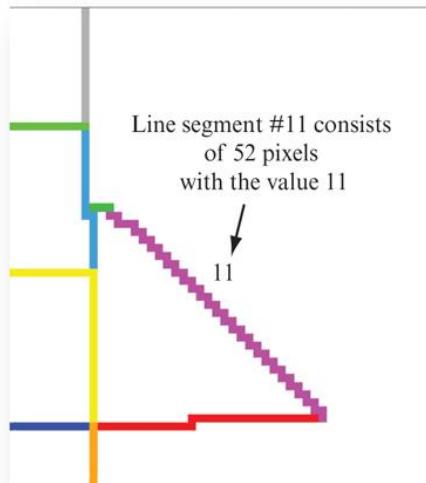
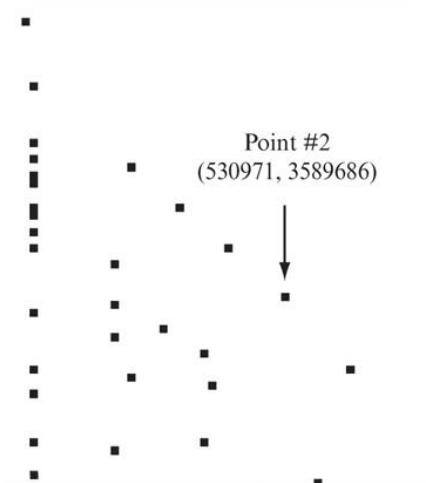
a. Point (Vector).



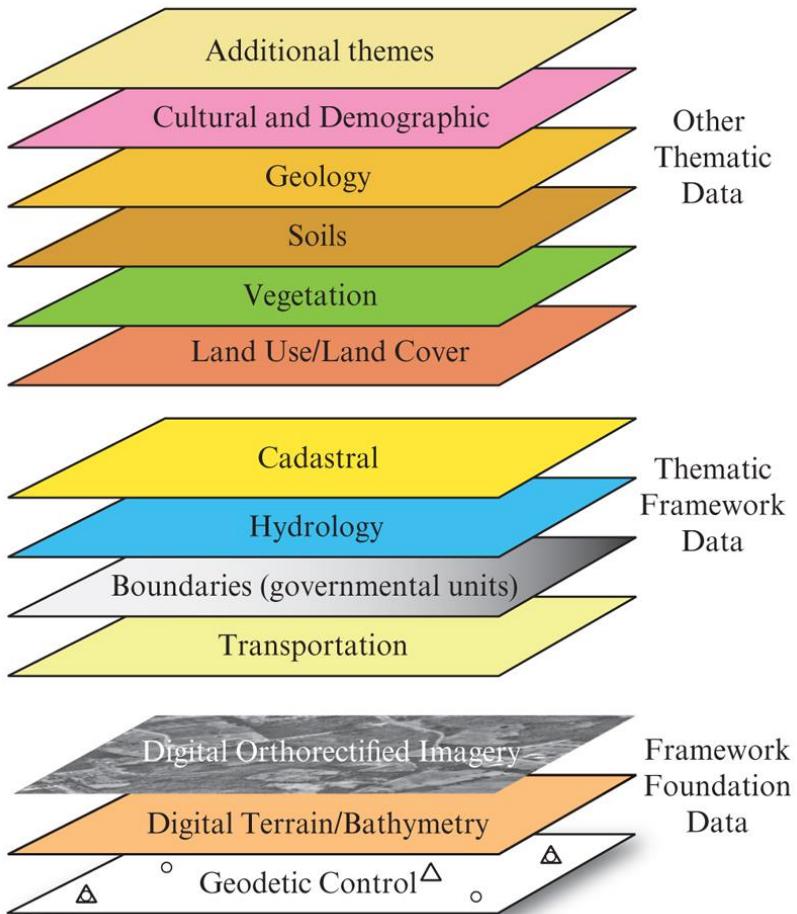
b. Line (Vector).



c. Area (Vector).



## National Spatial Data Infrastructure



## Selected Databases from the Beaufort County, SC, Spatial Data Infrastructure

