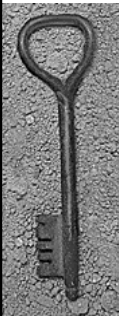




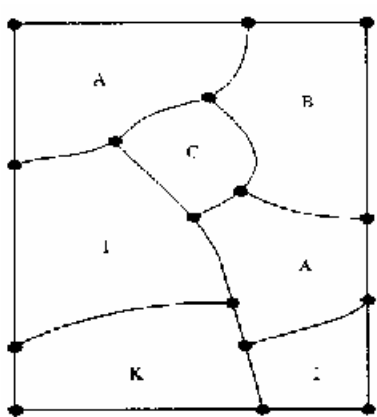
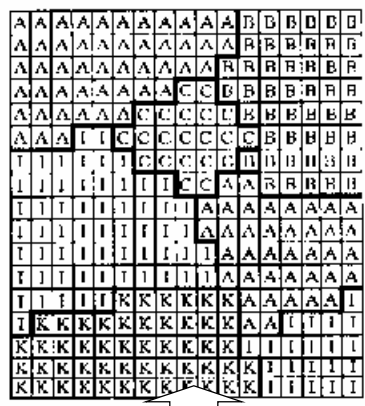
空間分析

(Spatial Analysis , SA)

The Heart of the GIS



資料模型 (vector and raster)

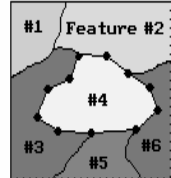



較常使用格式

How GIS Works: Vector Data Structure

MAPS AS DATA -- a GIS map is an organized set of numbers

MAP (Template)



X,Y
X,Y
X,Y
...

WHERE

MAP FEATURES

Template maps can be summarized for typical characteristics (average slope for each mapping compartment) and new fields are added to the database (create new spatial information).

A data base can be 'searched' for map compartments with certain requirements (large, young, Douglas fir stands on Cohasset soil); a map is produced locating these areas (repackage; display).

WHAT THEMATIC ATTRIBUTES

Linked by ID#

DATA BASE

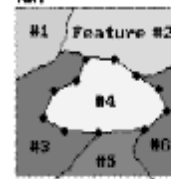
ID	SIZE	COVER	SOIL	AGE	ETC.
#1	65	MDW	ALU	>	-
#2	123	PP	COH	60	-
#3	206	PP	SRP	55	-
#4	119	DF	COH	5	-
#5	67	PP	SRP	55	-
#6	-	-			

...Vector data is ideally suited for Computer Mapping and Spatial Database Management

How GIS Works: Raster Data Structure

MAPS AS DATA -- raster data is an organized set of cells

MAP

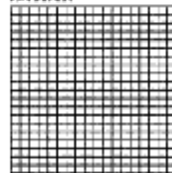


X,Y
X,Y
X,Y
...

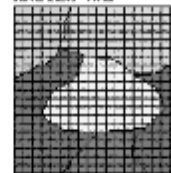
WHERE

MAP FEATURES

MATRIX



RASTER MAP



WHAT THEMATIC ATTRIBUTE

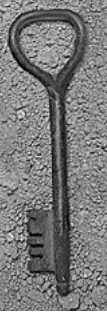
Linked by cell#

DATA BASE

cell#	ID	SIZE	COVER	SOIL	AGE
#1	#1	65	MDW	ALU	>
#2	#1	65	MDW	ALU	>
#3	#1	65	MDW	ALU	>
#4	#1	65	MDW	ALU	>
#5	#1	65	MDW	ALU	>
#6	#1	-	-		

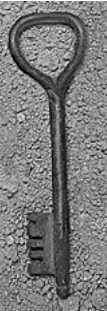
An imaginary grid is used to imply a set of contiguous cells covering an area. Each cell is assigned a value indicating its thematic characteristic.

...Raster data is ideally suited for GIS Modeling

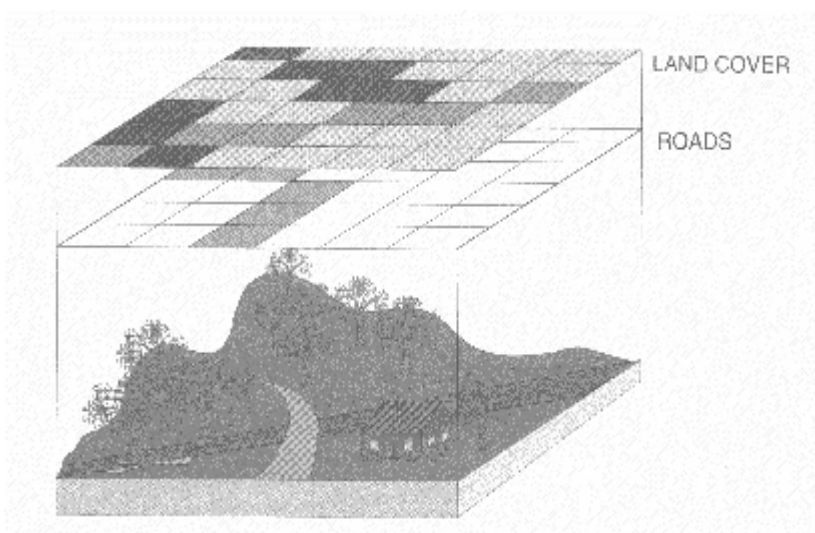


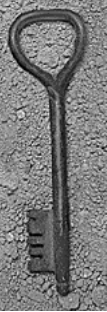
SA應用網格式資料優點

- ◆ Coordinate system is implied
- ◆ Neighborhood functions can be used (cells analyzed with respect to the cells around them)
- ◆ Accommodates discrete data such as soils as well as continuous data such as topography
- ◆ Processing algorithms are more efficient than vector routines
- ◆ Scanned data is inherently in a raster data structure
- ◆ Compatible with other data collection and manipulation software (e. g., remote sensing)



Raster/Grid/Cell Data Model

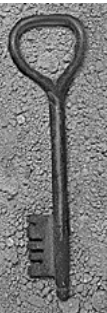




空間分析概念（I）

◆ Functional category

- Local operation
 - Recode/ mathematical transformation
- Focal operation
 - Neighborhood filtering/ terrain analysis/
- Zonal operation
 - Zonal shape/ zonal statistics
- Global operation
 - Spatial statistics....



空間分析之基本概念

- ◆ Bird's eye view – layer based (human)
- ◆ Worm's eye view – location based (computer)

特定區位

近鄰關係

分區特性

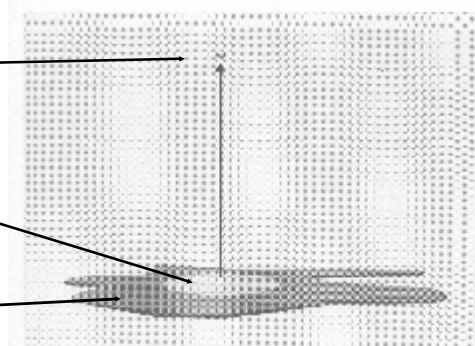


Figure 2-4: Major spatial analysis concepts. Operations that interpret data are performed on the data as a whole, such as data reduction, to obtain the new data. When the operations are performed on a specific location, they are called local operations, such as point operations, or on a neighborhood, they are called neighborhood operations.

Spatial Relationships(I)

- ◆ Individual Location
 - A specified grid or cell

Spatial Relationships(II)

- ◆ Neighborhood
 - A set of locations that are at specified cartographic distances and/or directions from a particular location

Spatial Analysis Kernel

1	1	1	1	1
1	1	1	1	1
1	1	4	1	1
1	1	1	1	1
1	1	1	1	1

Input image

x

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

Filter weights

=

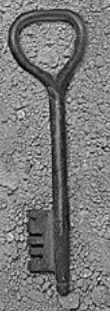
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

Output image

Kernel,
Template or
Filter

Spatial Relationships(III)

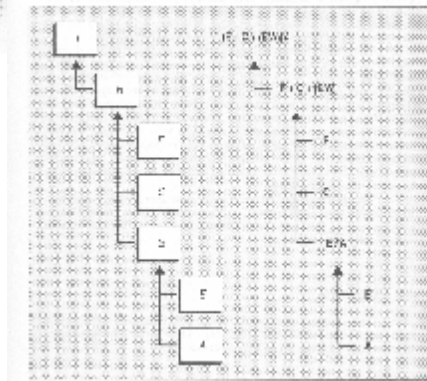
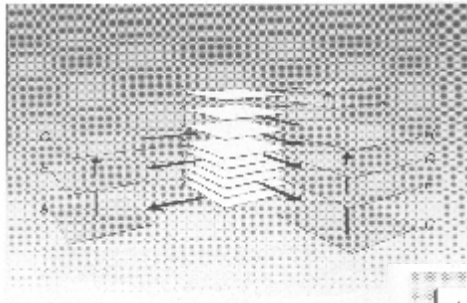
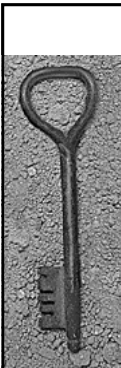
- ◆ Area
 - A group of locations that are bounded in a specified area

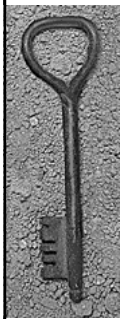


空間分析概念（Ⅱ）

◆ Map layers

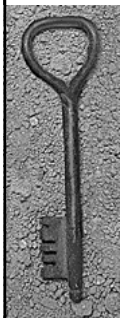
- Single layer
- Pairs of layers
- Multiple layers





空間查詢

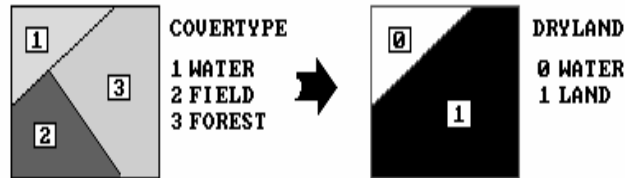
- ◆ 空間查詢
 - 空間關係查詢
 - 屬性查詢
- ◆ 多數所需求的GIS功能，大多屬於查詢的功能
- ◆ 單一圖層
- ◆ 多圖層



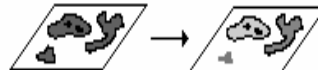
分類(classification)

- ◆ 所謂分類(classification)，乃是由圖徵中，辨識出具有共同性質(或是屬性)的部份，加以歸類成一組的運算
- ◆ 外部資料之屬性分類，不能完全適合分析工作時，需進行重分類(reclassification)
- ◆ 重分類的結果，有些不同的區域可能因而對應至相同的類別而需要加以聚合(aggregation)

RECLASSIFYING MAPS -- 'Recoloring Maps'

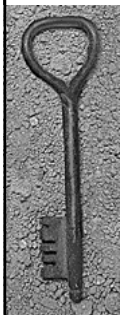


Newmap values a function of values on a single existing map; no new spatial information is created.



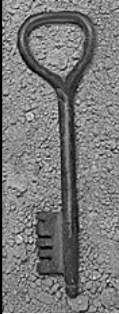
- o Position -- Scale, Projection, Rotation, Coordinates
- o Initial Value -- Relabeling, Aggregating, Weighting, Constant Math, Contouring
- o Size -- Number, Length, Perimeter, Area, Volume
- o Shape -- Spatial Integrity, Boundary Configuration
- o Contiguity -- Clumps

Reclassify operations merely 'repackage' existing map information such as generating a binary land/water map from a covertime map.



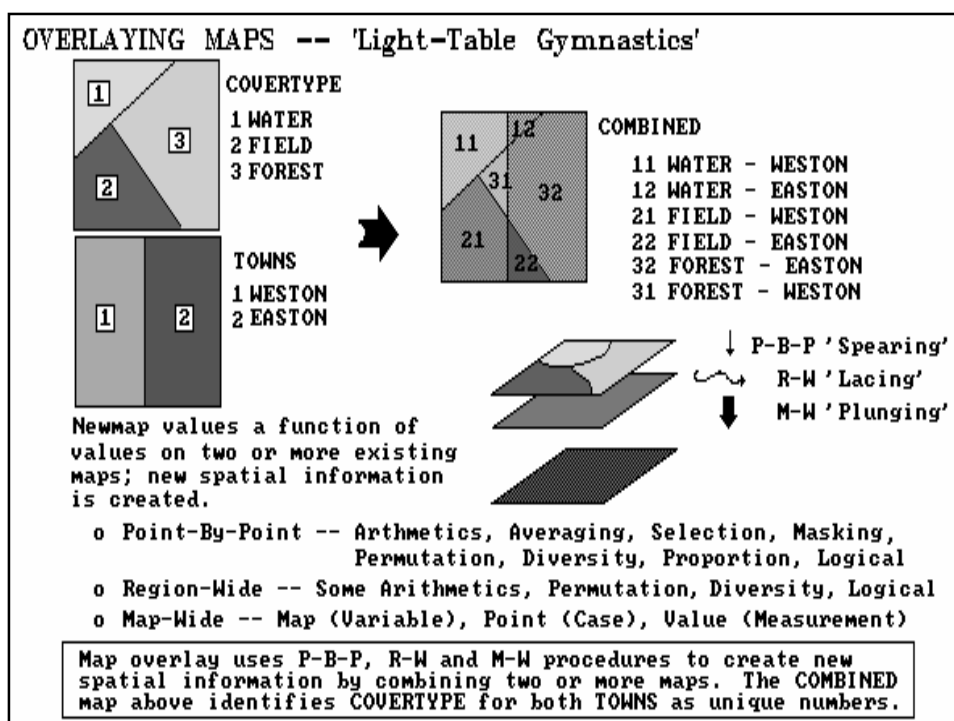
環域分析(Buffering)

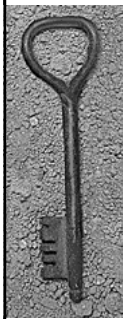
- ◆ 距離空間物件某一指定距離內的區域，我們稱之為環域(Buffer)
- ◆ GIS所提供的環域功能，包括對點、線、面(面再分為由面的邊緣向內與向外兩種)的環域運算
- ◆ 某一污染源對外的擴散區域(點環域)、捷運沿線的噪音污染情況(線環域)、某地區(如學校、醫院)應受隔離的範圍(面的向外環域)、部隊營區警戒區域之劃定(面的向內環域)
- ◆ 在進行環域處理時環域的寬度有時不見得要一致，對某些應用而言，環域的寬度可能會依圖徵的屬性而有所差異



兩張以上圖層空間分析處理

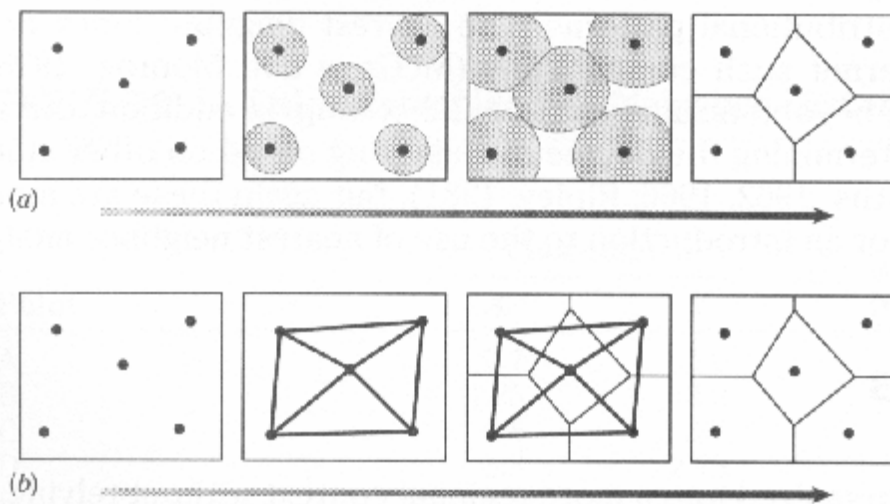
- ◆ 疊合分析Overlaying
- ◆ Map algebra
- ◆ Map calculator (in Arcview)
 - Arithmetic
 - Logical
 - trigonometric
 - Logarithmic
 - Power



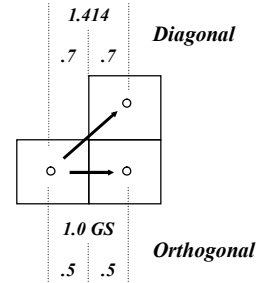
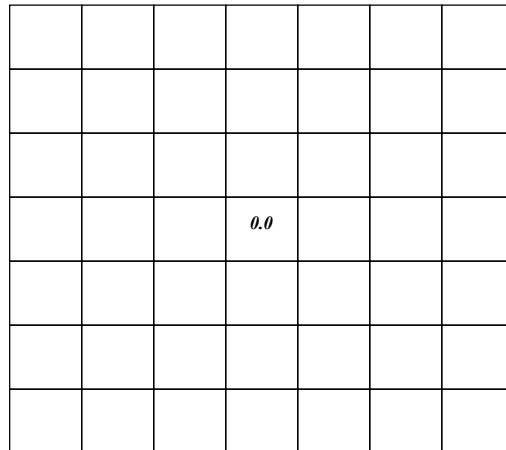


Voronoi圖形

- ◆ 又稱為徐昇氏多邊形(Thiessen's Polygon)
- ◆ 將一個水平面上的所有面積，按照指定的若干資料點，分成數個多邊形，而每個多邊形內恰含有一個資料點
- ◆ 對於任一個多邊形內的任何一點而言，它和多邊形外其它資料點的距離，均大於它和該多邊形內所分配的資料點距離。
- ◆ Voronoi圖形的任何一個分隔邊均有一個特性，也就是它和兩邊的兩個資料點之距離恰為等距。任一資料點的Voronoi圖形之邊，乃是由此資料點和相鄰各資料點連線的垂直平分線所構成。



Measuring Distance As “Waves” (splash)

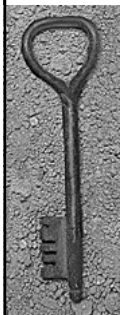


Simple Distance – orthogonal step (1.0); diagonal step (1.414); concentric rings (waves); retain minimum distance

Weighted Distance – half steps times the impedance factor (friction); absolute barriers have infinity assigned; relative barriers are expressed as friction values

...like all movement, it starts somewhere (starter cell) and moves through geographic space by steps (wave front)

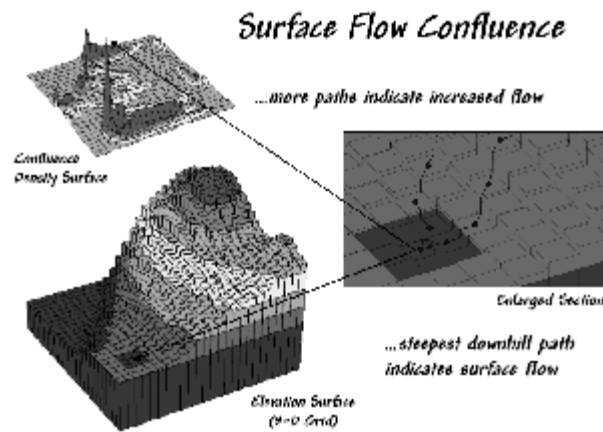
(Berry)



擴散分析

- ◆ 擴散分析，係由一個點出發，向外逐步擴張，並且逐步累積觀察的值。換言之，擴散分析是以某一參考點為基準，就其鄰近範圍內，依指定的計算函數求出結果。
- ◆ 前述函數可運用在空間統計中，例如：求參考點近鄰範圍內目標物之總數、平均數、變異數、眾數、...等等。當我們所要觀察的值是行經的距離，且出發點和目的點中間沒有障礙物時，這種特殊的情形便稱為鄰近度分析(proximity)
- ◆ 擴散分析在實作上，最大的困難點在於它必須處理相當多的網格資料點，在記憶體管理上是一項相當大的挑戰
- ◆ 結合尋徑分析與擴散分析，可以找到任一點和出發點之間的最佳路徑

Establishing Optimal Paths



Stream -- like a raindrop, the "steepest downhill" path identifies the optimal path. If the surface is a proximity map, the optimal path identifies the shortest (not necessarily straight) route between any location on the surface and the closest starting cell (point, line or area).

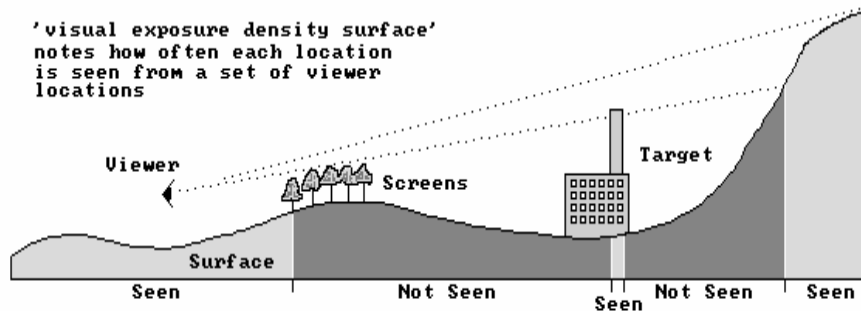
Drain -- accumulates the optimal paths from many locations. Higher "Drain" values indicate locations that have numerous optimal paths passing through it.

(Berry)

視域分析

VISUAL EXPOSURE -- line-of-sight contact from location(s) to everywhere

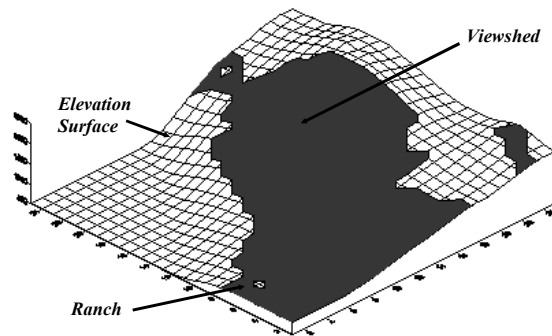
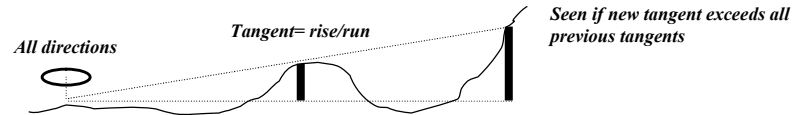
'visual exposure density surface' notes how often each location is seen from a set of viewer locations



"Viewsheds" characterize the inter-visibility among locations. Straight lines in 3-dimensional space connect locations forming the viewshed from viewer location(s).

(Berry)

Calculating Visual Connectivity



Radiate – visual exposure is calculated by a series of “waves” that carry the tangent to beat.

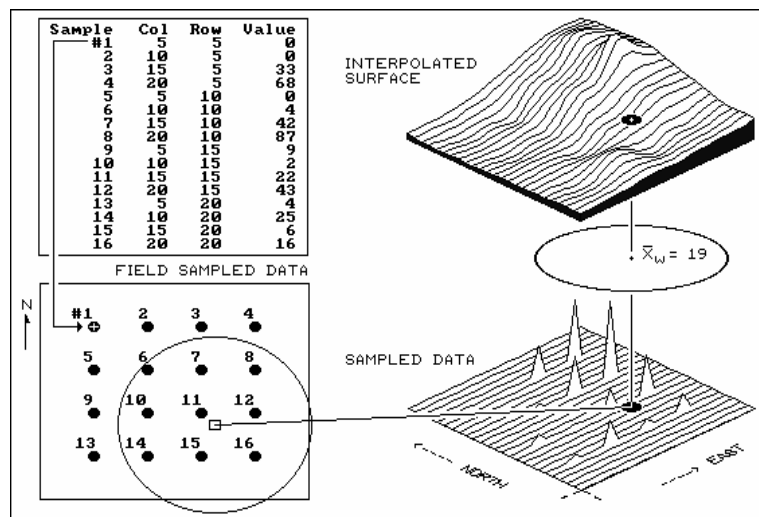
Simply – viewshed
Completely – number of “viewers” that see each location
Weighted – viewer cell value is added

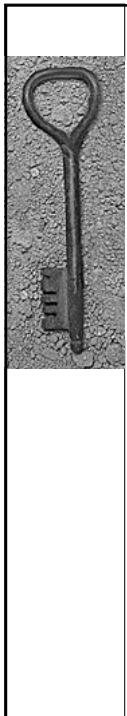
...like Spread, it starts somewhere (starter cell) and moves through geographic space by steps (wave front)

(Berry)

空間（地形）内插分析

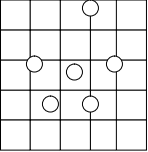
Interpolation Techniques (Inverse Distance, Kriging, MinCurve)





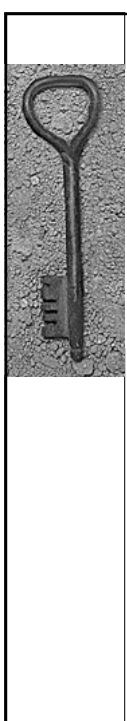
What is Interpolation?

- ◆ Interpolate from sample points
- ◆ Procedure to estimate values at unsampled locations within sampled region
- ◆ Example: Terrain, pH value, water quality
- ◆ Based on the principle of spatial autocorrelation or spatial dependence
 - Spatial autocorrelation — measures degree of relationship/dependence between near and distant objects



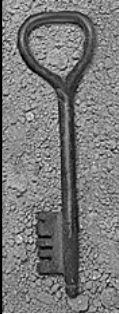
- ◆ Implements Tobler's First law of Geography:

"everything is related to everything else, but close things are closely related"



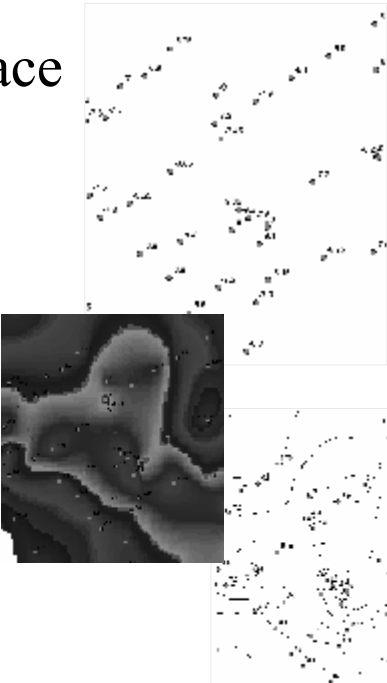
Elements of interpolation

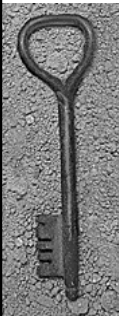
- ◆ The known points (samples)
 - Sample factors - size, limits, location ,outliers
- ◆ The unknown points (interpolated values)
 - Interpolation models:
 - Deterministic - create surfaces from measured points, based on either the extent of similarity (IDW) or degree of smoothing (Trend).
 - Geostatistical - based on statistics (Kriging) with advanced prediction modeling, includes measure of certainty or accuracy of predictions.
- ◆ Different interpolation methods will (almost always) produce different results.



Sampling a surface

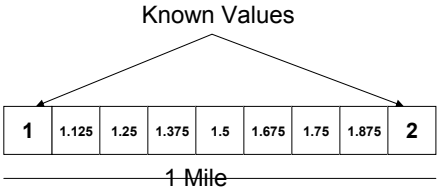
- ◆ Perfect surface requires infinite number of measurements
- ◆ Therefore samples need to be significant and random, if possible
- ◆ Error increases away from sample points

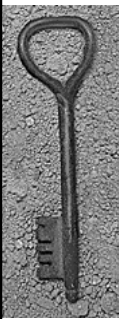




Linear interpolation

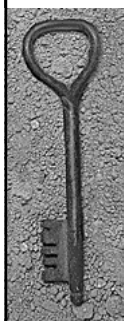
- ◆ Interpolation of cell values
 - A best estimate between samples
- ◆ May consider:
 - Distance
 - Weight
- ◆ Used for:
 - Predicting
 - Forecasting
 - Describing
 - Understanding
 - Calculating
 - Estimating
 - Analyzing
 - Explaining





Controlling sample points for interpolation

- ◆ IDW, Spline & Kriging support control of sample numbers
- ◆ Sample methods:
 - Nearest neighbors — you choose how many
 - Search radius — variable or max distance
- ◆ Returns *NoData* if insufficient samples



地理資料分析與應用

- ◆ 屬性資料分析
 - 適用一般MIS的處理程序與技術（如DBMS）
 - 分析上適合採用其他之統計或分析軟體（如SPSS、SAS、S-PLUS等）
 - 查詢、運算或彙整（summarize）處理
 - 地理編碼（geo-coding）與地址對位（address matching）
- ◆ 空間分析




On a table with addresses, specify the address fields.

Address tables can contain addresses with either two or four address fields.

table with two address fields

table with addresses	
18 Quinn Rd	43502
221 Luna Dr	10010
110 Michaels St	90210
90 Francisco Ave	94112

field with house number and street name

field with city, state, or postal code

table with four address fields

table with addresses			
413 Beryl Blvd	Paradise	CA	92673
22 Ula Lane	Taco	NM	87501
86 Chloe Court	Volante	NM	87505

field with house number and street name

city field

state field

postal code field

Select an address locator and set spelling sensitivity.

Address locators include:
 - All postal addresses
 - All original address ranges
 - All original address ranges
 - All original address ranges
 - All original address ranges

You can match addresses against a street network with address ranges or point or polygon data that has addresses as attributes.

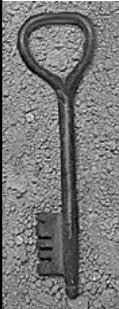


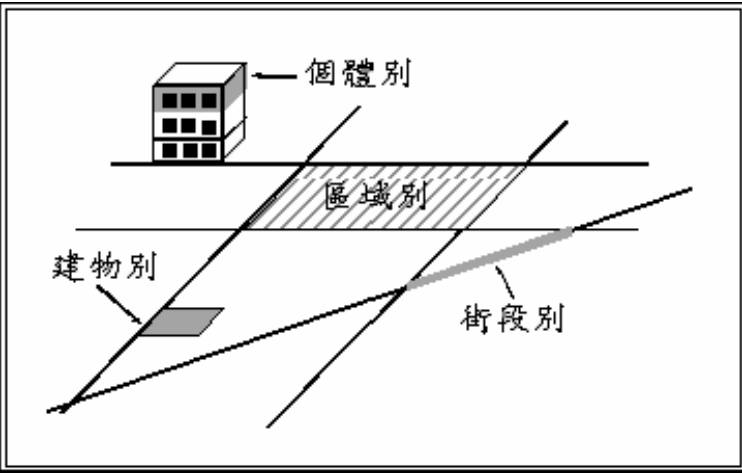
Following the national postal conventions, positions are found for each address and points are created in a new feature class. Standardized addresses are optionally written to a field.

Matching addresses can be ambiguous because of spelling errors and incomplete addresses. After you have processed an address table, you will find a percentage of point features for which no position was created. You can preprocess these missing addresses and correct them.

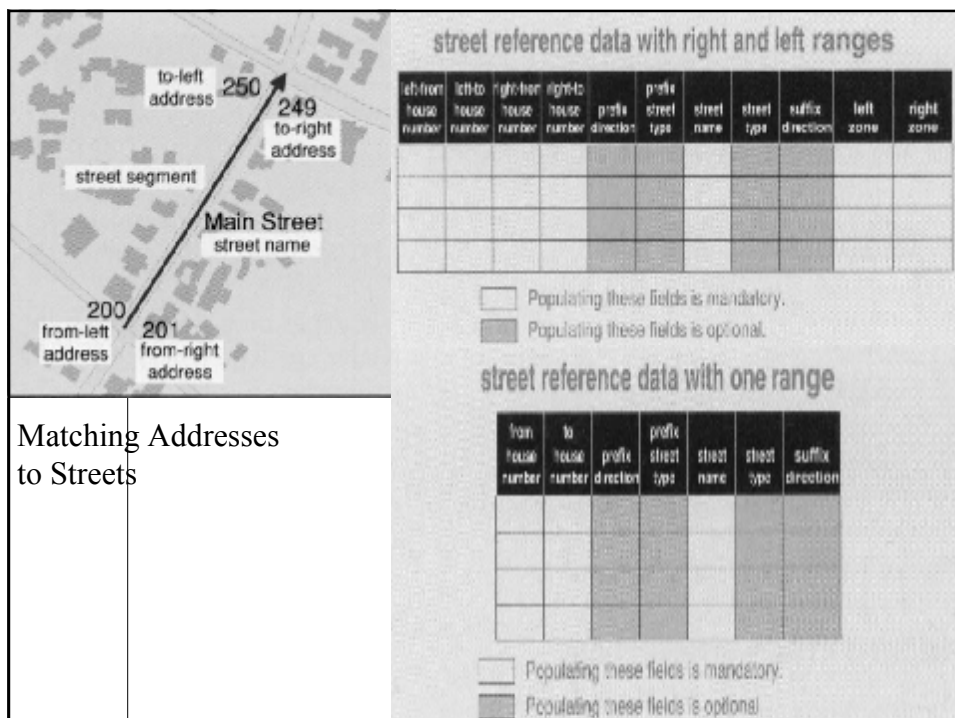
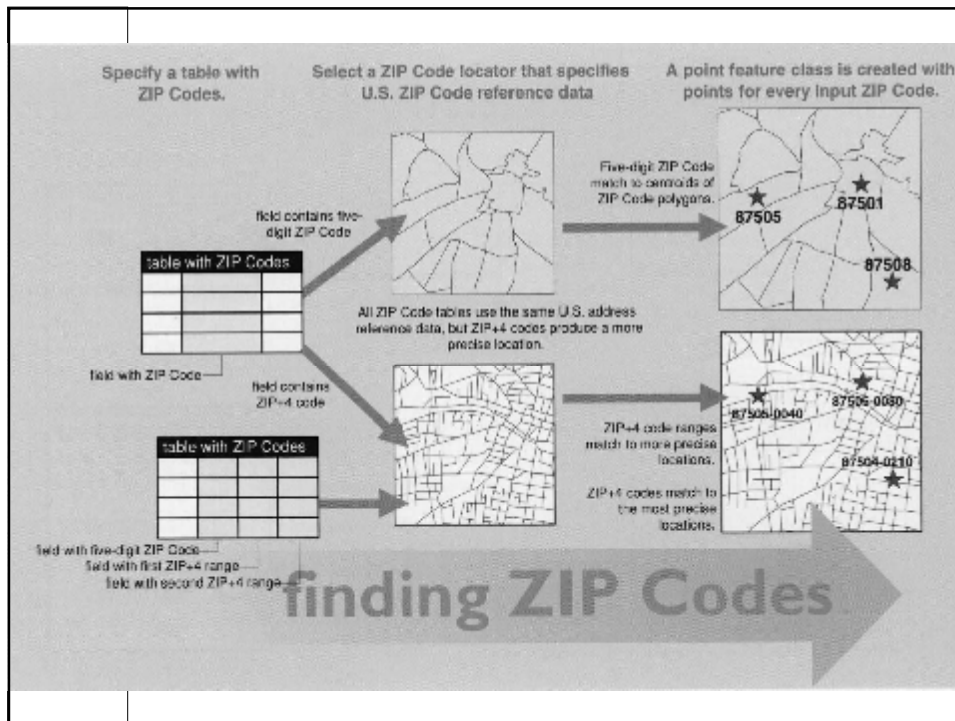


finding addresses





圖二地址對位的四種方式



Finding Building Addresses

table with addresses		
	109 Montezuma	
	111 Montezuma	
	115 Montezuma	
	121 Montezuma	

field with house number
and street name



building reference data

The standard
address locator
uses these fields in
the building
reference data.

house number	prefix direction	prefix street type	street name	street type	suffix direction	zone

- ☐ Populating these fields is mandatory.
- ☐ Populating these fields is optional.