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Chapter 11

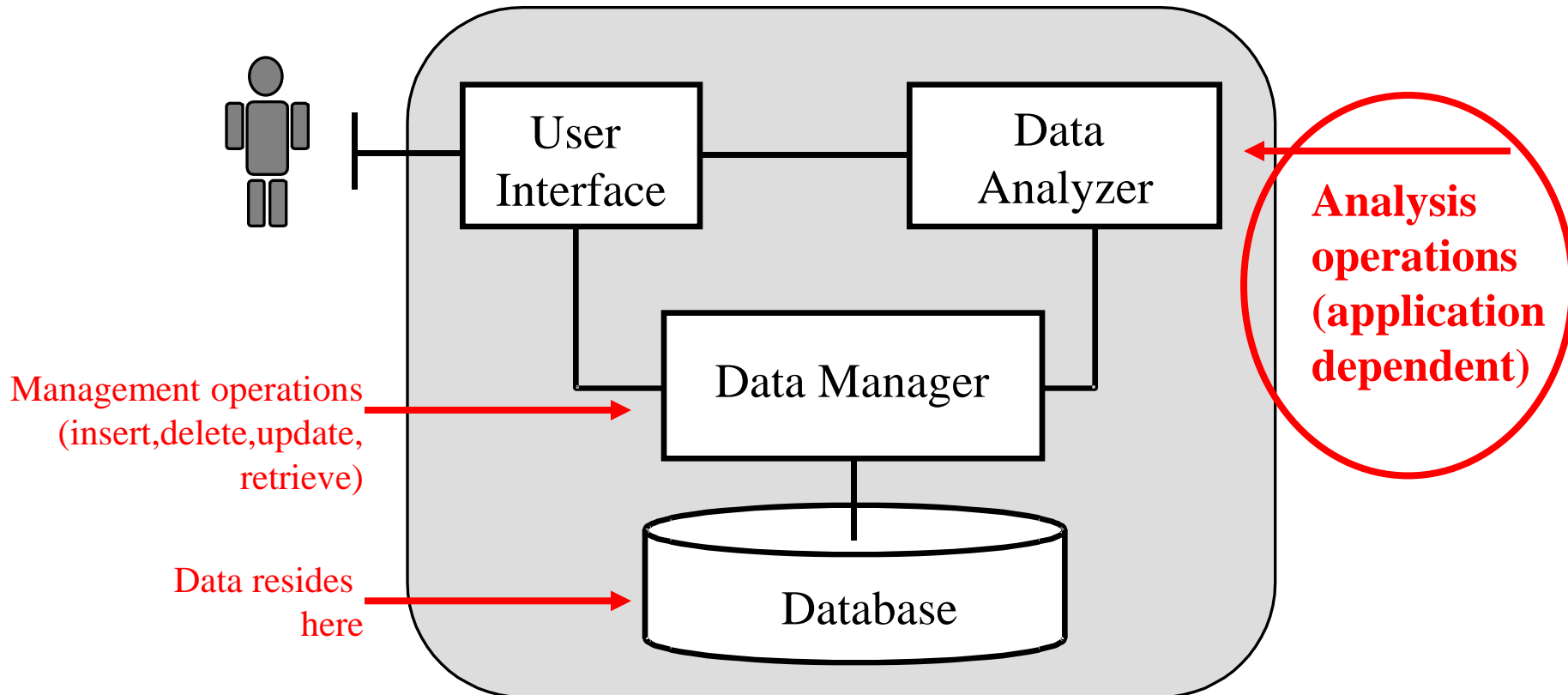
Geographic Data Analysis

Emmanuel Stefanakis

<http://www2.unb.ca/~estef/>

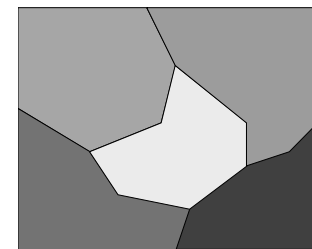
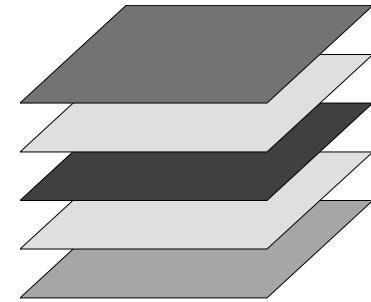
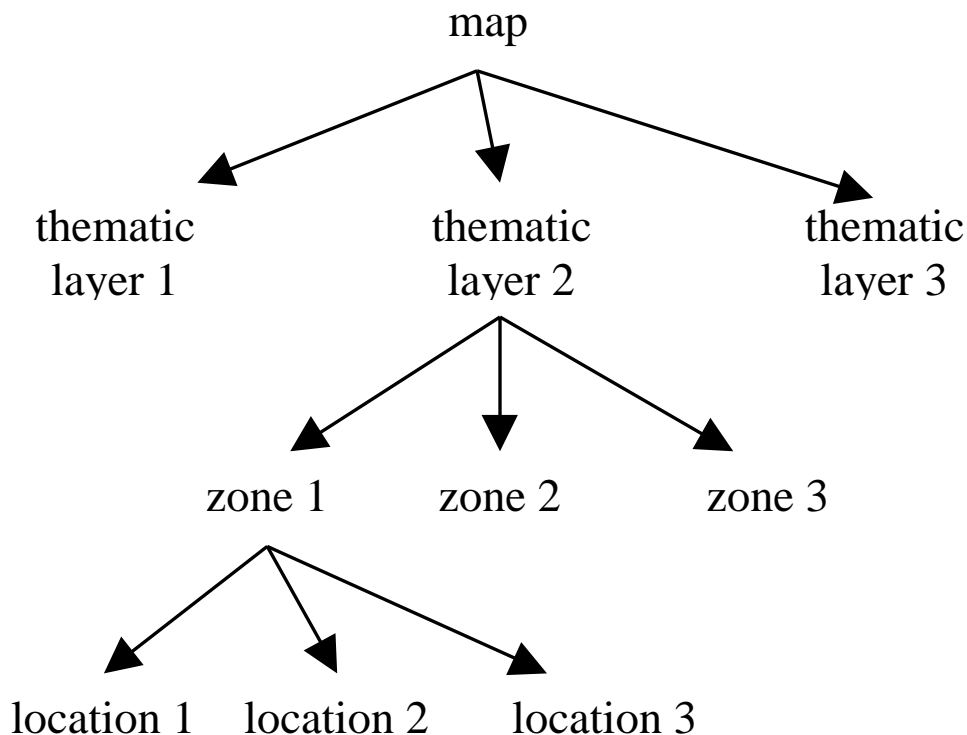
Geographic Information Systems

- Information System



Representation of Geographic Data

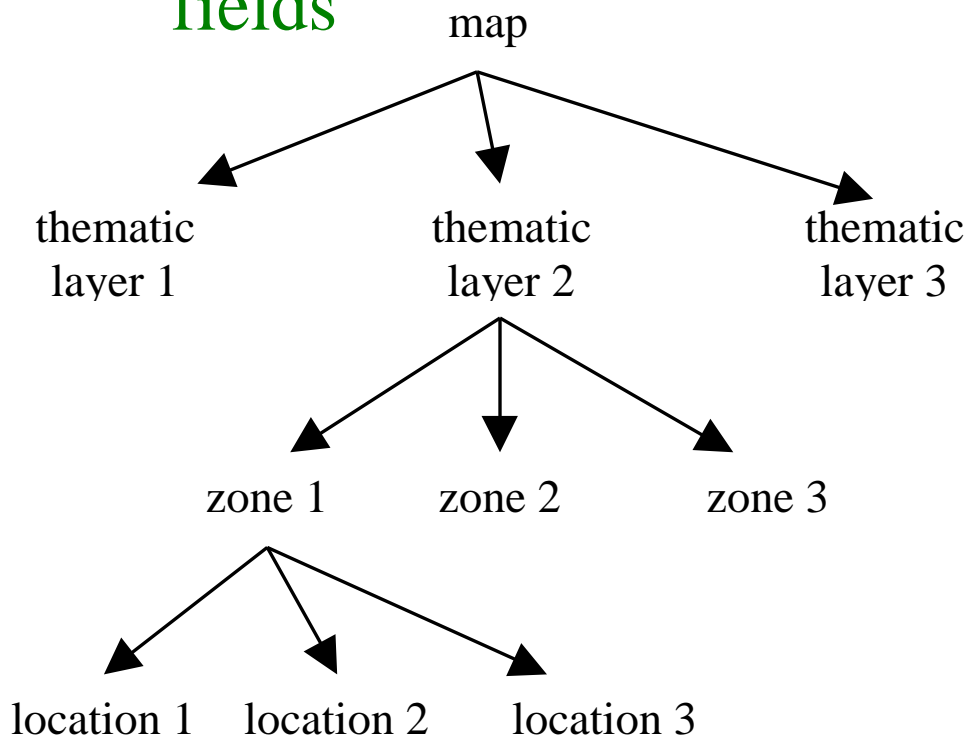
- Tomlin's Model...
 - geographic data forms a hierarchy



Representation of Geographic Data

- Tomlin's Model...

- represents both discrete entities and continuous fields

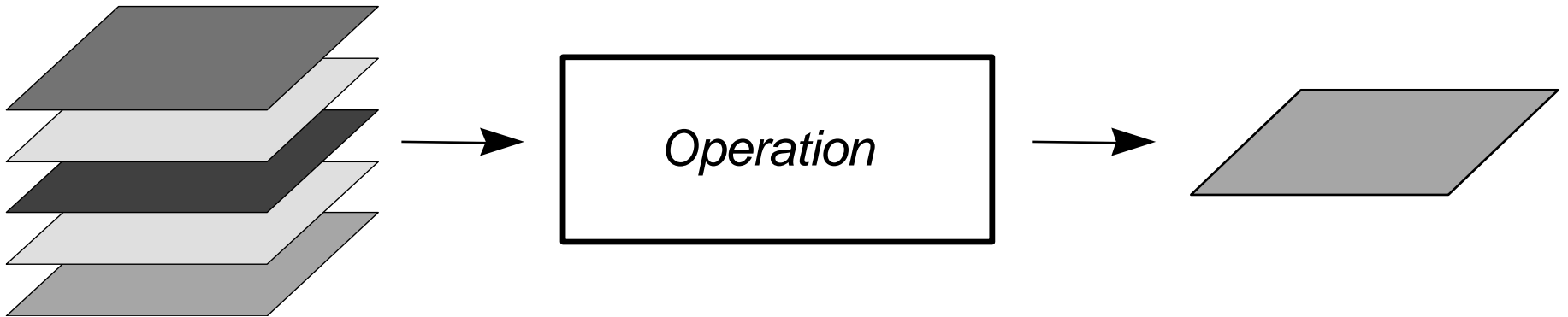


← **Continuous fields
(raster)**

← **Discrete entities
(vector)**

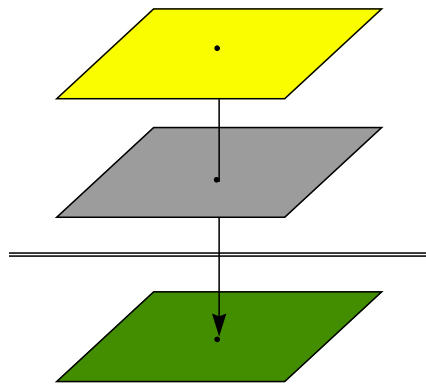
Geographic Operations

- An operation ...
 - based on Tomlin's model

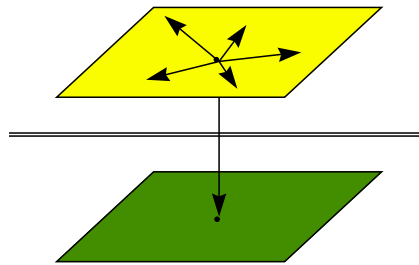


Geographic Operations

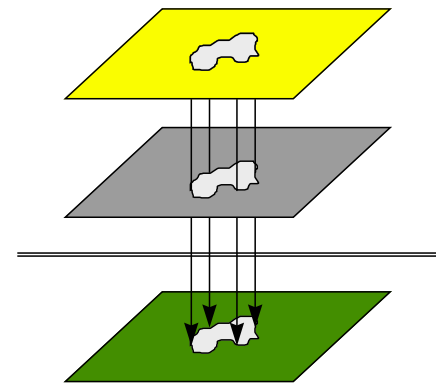
- Classification of operations ...
 - based on Tomlin's model



Local operations



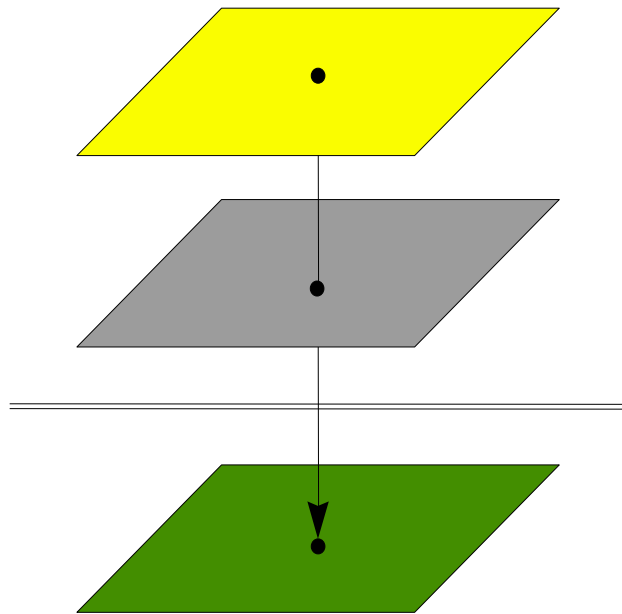
Focal operations



Zonal operations

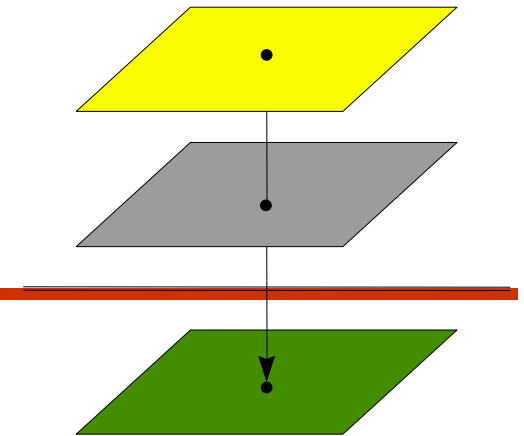
Geographic Operations

- Local operations ...



compute a new value for
each location on a layer
as a function of existing
data explicitly
associated with that
location

Geographic Operations



- Local operations ...

Classification

23	25	33	28
25	32	34	29
34	31	32	29
29	37	28	27



value > 30

0	0	1	0
0	1	1	0
1	1	1	0
0	1	0	0

e.g., temperature

Geographic Operations

- Local operations ...

Overlay

3	5	3	8
5	2	4	9
4	1	2	9
9	7	8	7

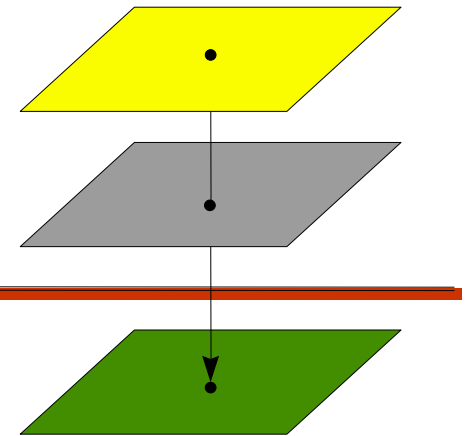
+

2	2	3	2
2	3	3	2
3	3	3	2
2	3	2	2



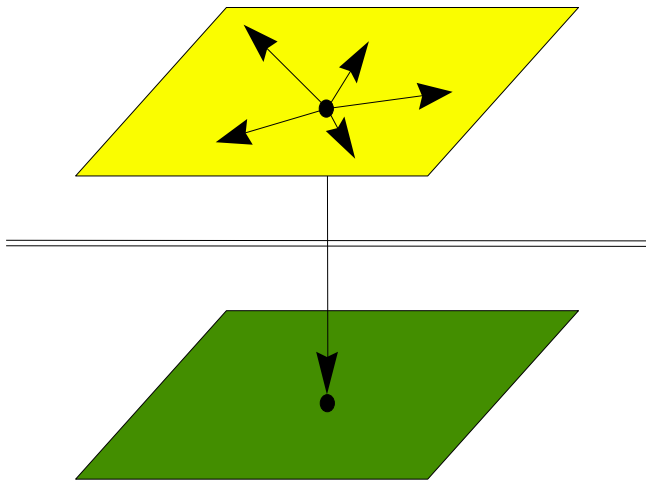
5	7	6	10
7	5	7	11
7	4	5	11
11	10	10	9

*e.g.,
anglophones+francophones*



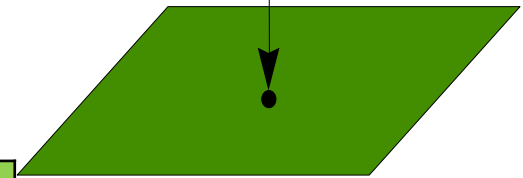
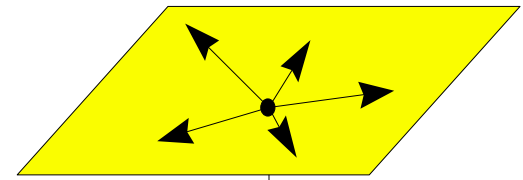
Geographic Operations

- Focal operations ...



compute new values
for every location as a
function of its
neighborhood

Geographic Operations



- Focal operations ...

Sum of
direct neighbors

(dynamic
neighborhood)

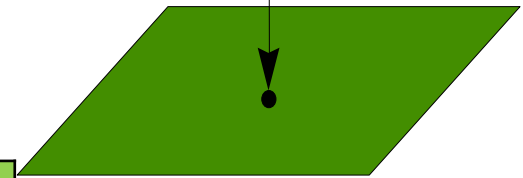
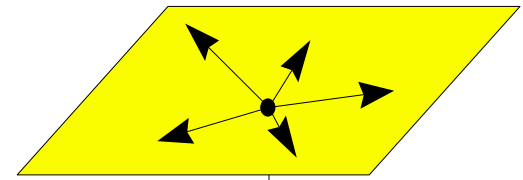
2	1	1	2
2	3	3	3
1	4	4	2
3	1	4	2



5	7	7	6
8	13	14	10
10	13	17	11
5	12	11	8

e.g., slope or aspect

Geographic Operations



- Focal operations ...

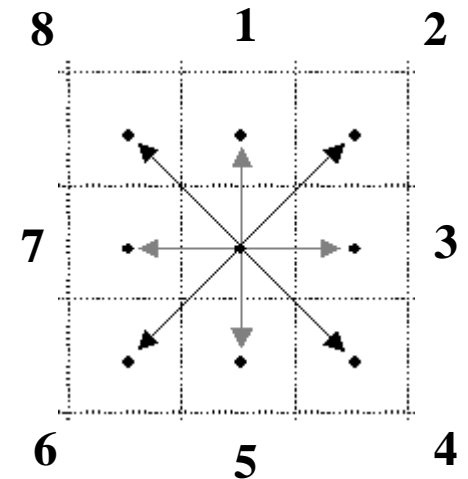
Direction to
direct neighbors

(static
neighborhood)

0	0	0	0
0	0	0	0
0	1	1	0
0	0	0	0



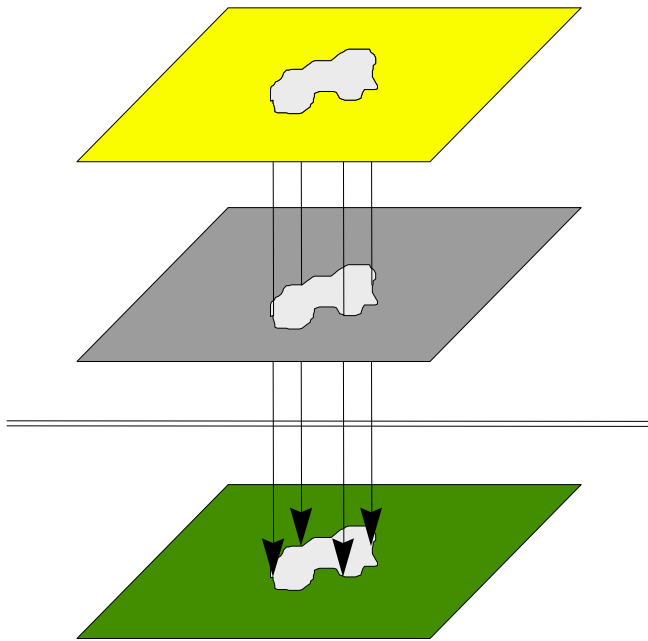
8	1	1	2
8	1	1	2
7	0	0	3
6	5	5	4



e.g., direction relation

Geographic Operations

- Zonal operations ...



compute a new value
for each location as a
function of existing
values associated with a
zone containing that
location

Geographic Operations

- Zonal operations ...

Search

Q	Q	Q	Q
Q	Q	Q	Q
Q	Q	NB	NB
Q	Q	NB	NB

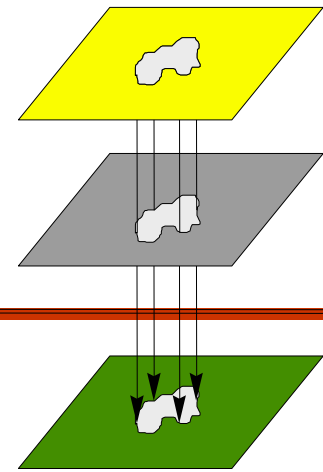
AND

F	L	L	L
F	F	F	F
L	L	F	F
L	L	F	L

e.g., forests (F) in NB



0	0	0	0
0	0	0	0
0	0	1	1
0	0	1	0



Geographic Operations

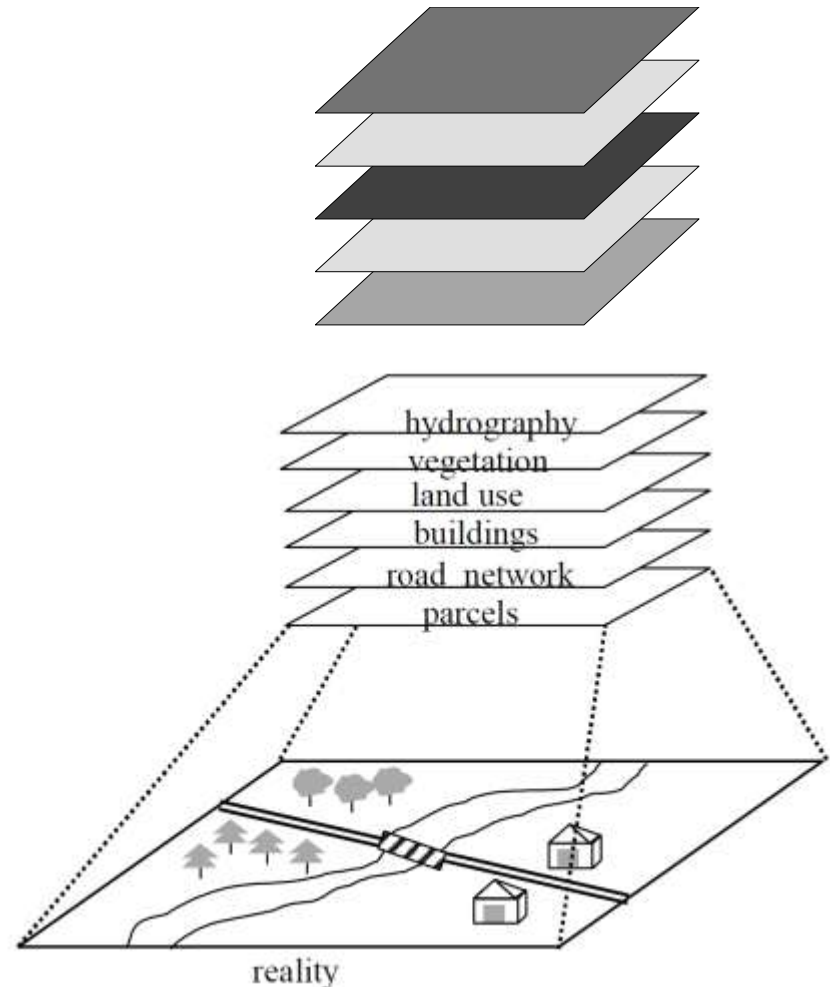
Classes of Operations	Examples of Operations
<i>Local Operations</i>	
• Classification & recoding	<i>re-code, re-compute, re-classify</i>
• Generalization	<i>generalize, abstract</i>
• Overlay (spatial join)	<i>overlay, superimpose</i>
<i>Focal Operations</i>	
• Neighborhood	
– window & point queries	<i>zoom-in, zoom-out, point-in-polygon</i>
– topological	<i>disjoint, meet, equal, contains, inside, covers, overlap</i>
– direction	<i>north, north-east, weak-bounded-north, north-south</i>
– metric (distance) & buffer zones	<i>near, about, buffer, corridor, thinning</i>
– nearest neighbor	<i>nearest-neighbor, k-nearest-neighbors</i>
• Interpolation	
– location properties	<i>point-linear, (inverse) distance-weighted</i>
– thiessen polygons	<i>thiessen-polygons, voronoi-diagrams</i>
• Surficial	
– visualization	<i>contours, TINs</i>
– location properties	<i>height, slope, aspect, gradient</i>
• Connectivity	
– routing & allocation (network)	<i>optimum-path-finding, optimum-routing, spread, seek</i>
– intervisibility	<i>visible, light-of-sight, viewshed, perspective, illumination</i>
<i>Zonal Operations</i>	
• Mask queries (spatial selection)	<i>select-from-where, retrieve</i>
• Measurement	<i>distance, area, perimeter, volume</i>

Example...

- The problem...
 - find ...
 - best location(s) **for residential housing development...**
 - Constraints and opportunities
 - Free land (no development)
 - Dry land
 - Level and Smooth land (slope < 10%)
 - Close to existing roads
 - South slope
 - Adequate size (>1.5 km²)

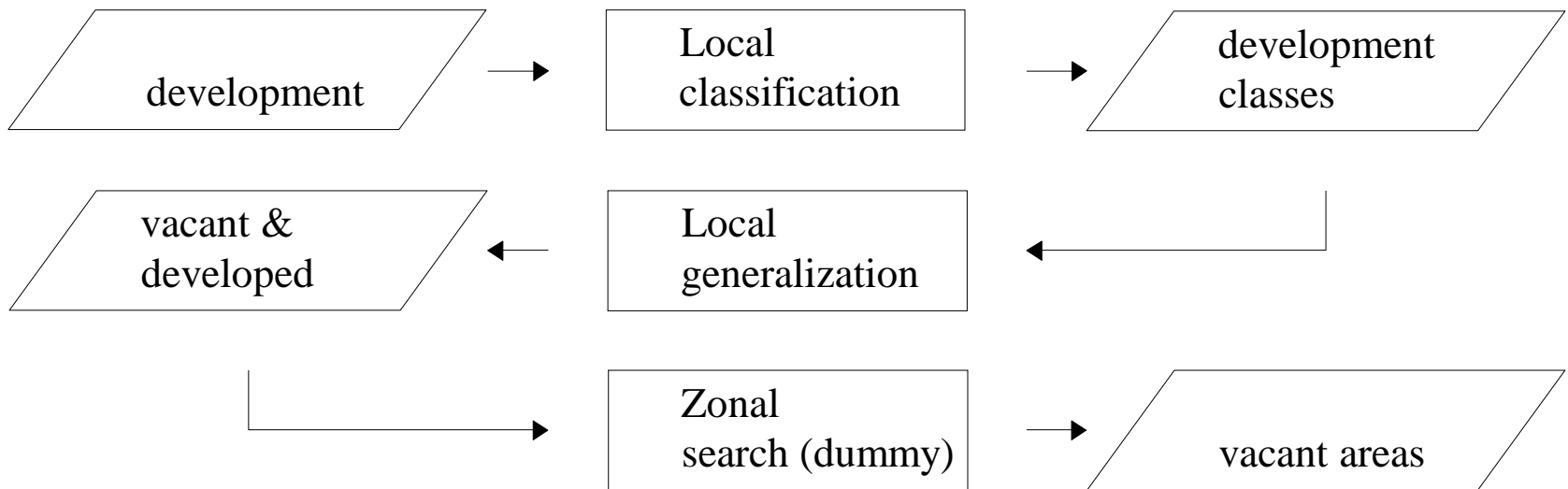
Example...

- Input layers
 - Hypsography
 - Development
 - Humidity



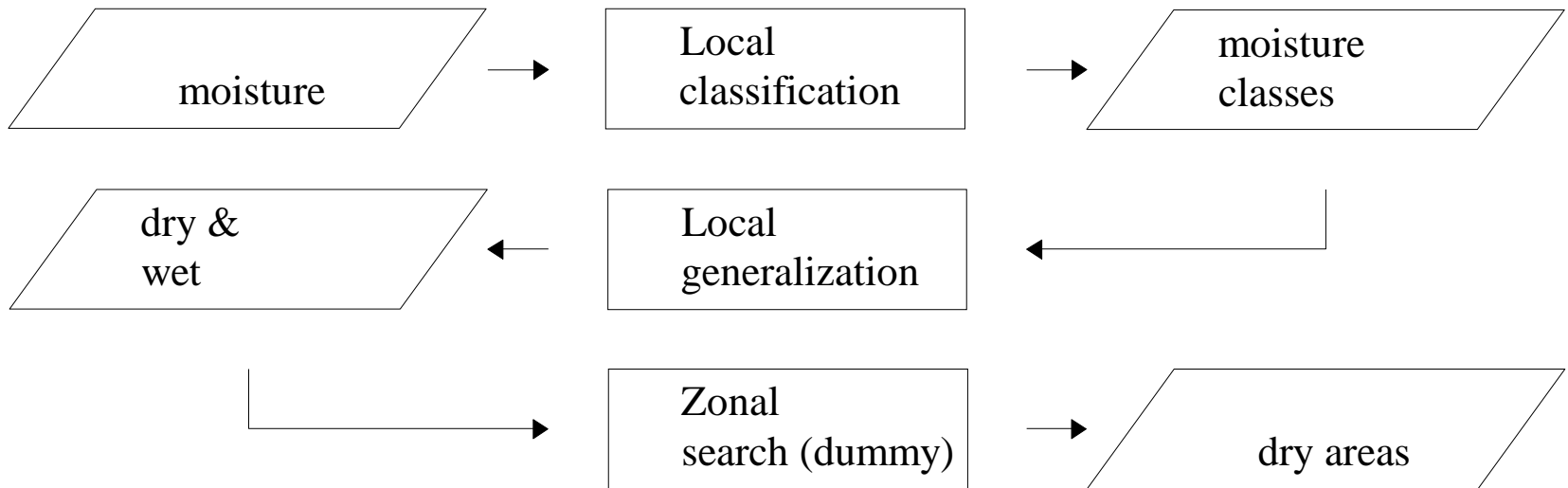
Example...

(1) Find vacant areas...



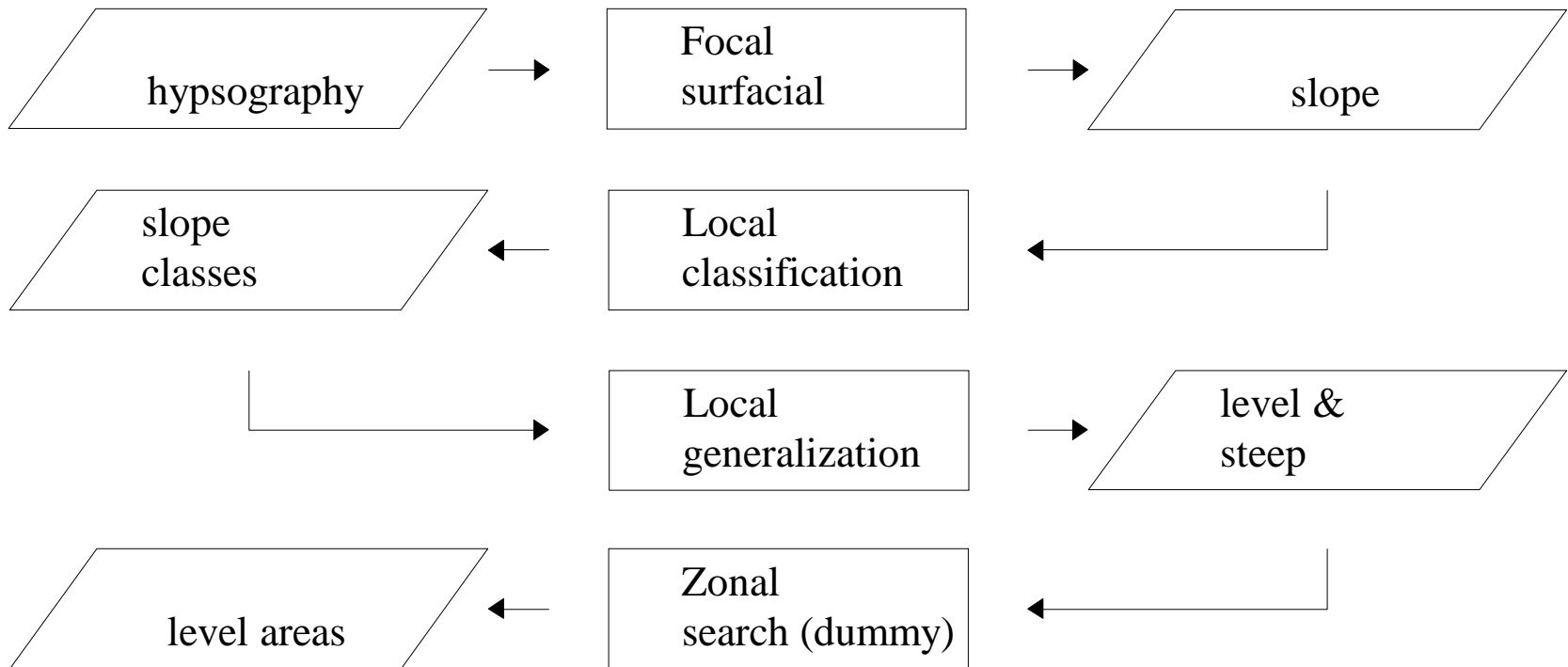
Example...

(2) Find dry areas...



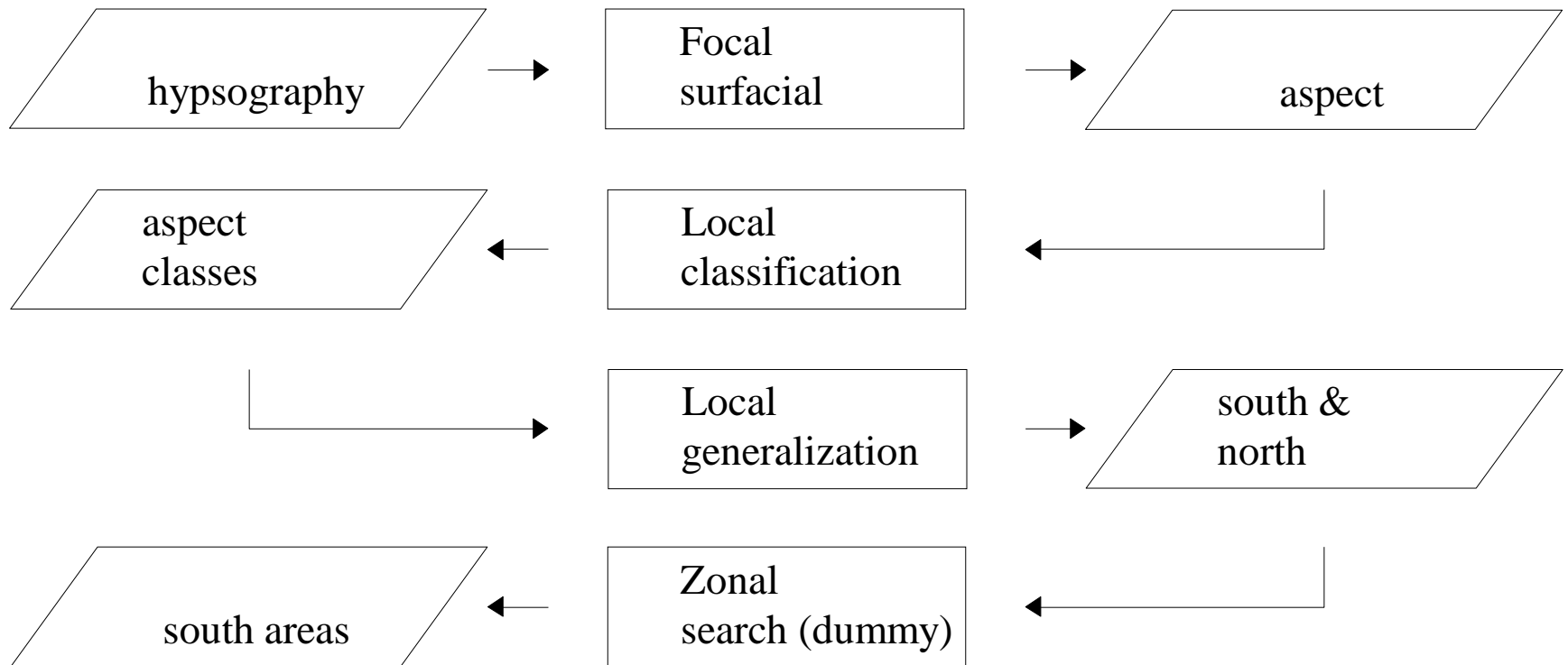
Example...

(3) Find level areas...



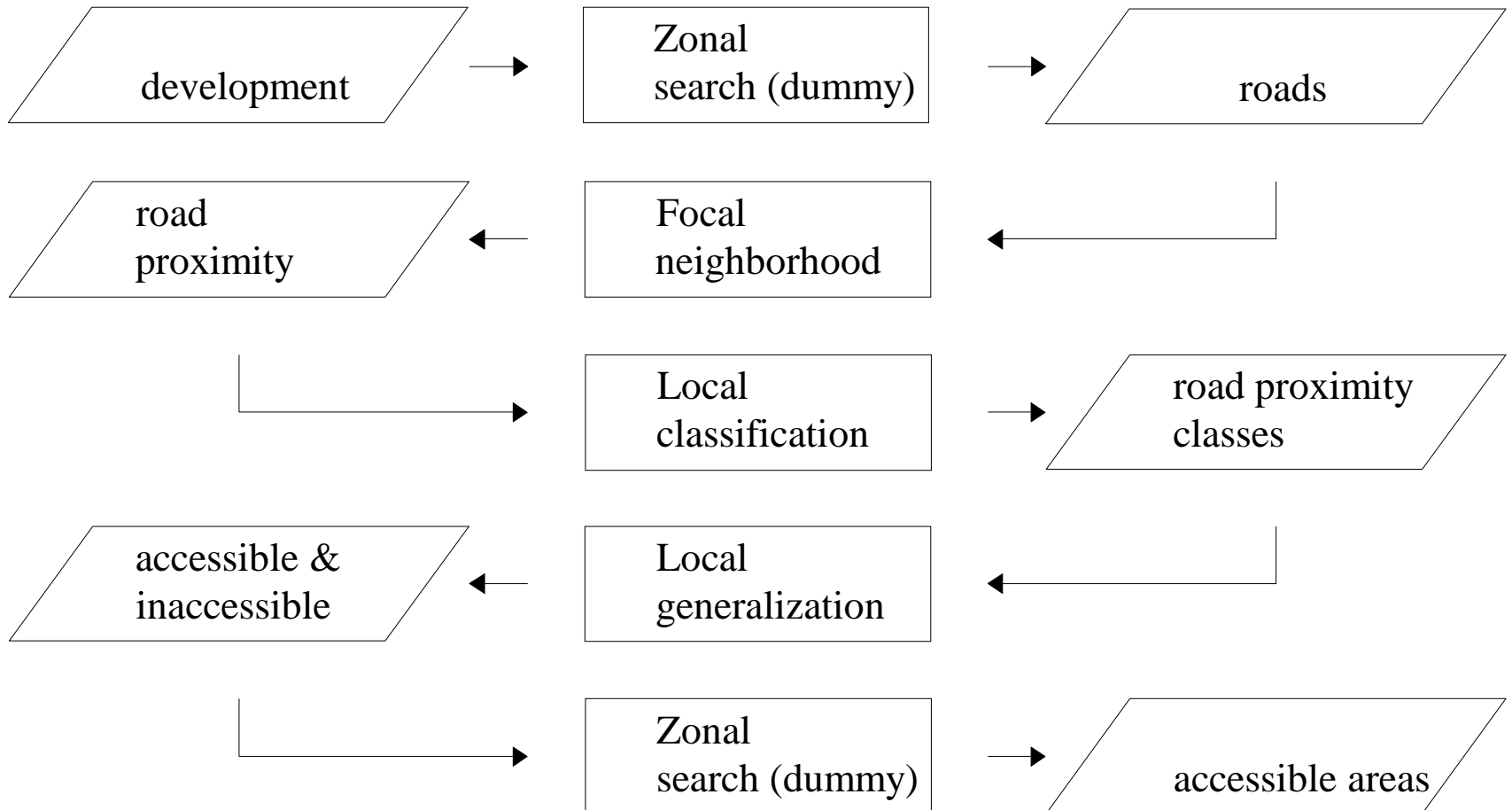
Example...

(4) Find south-facing areas...



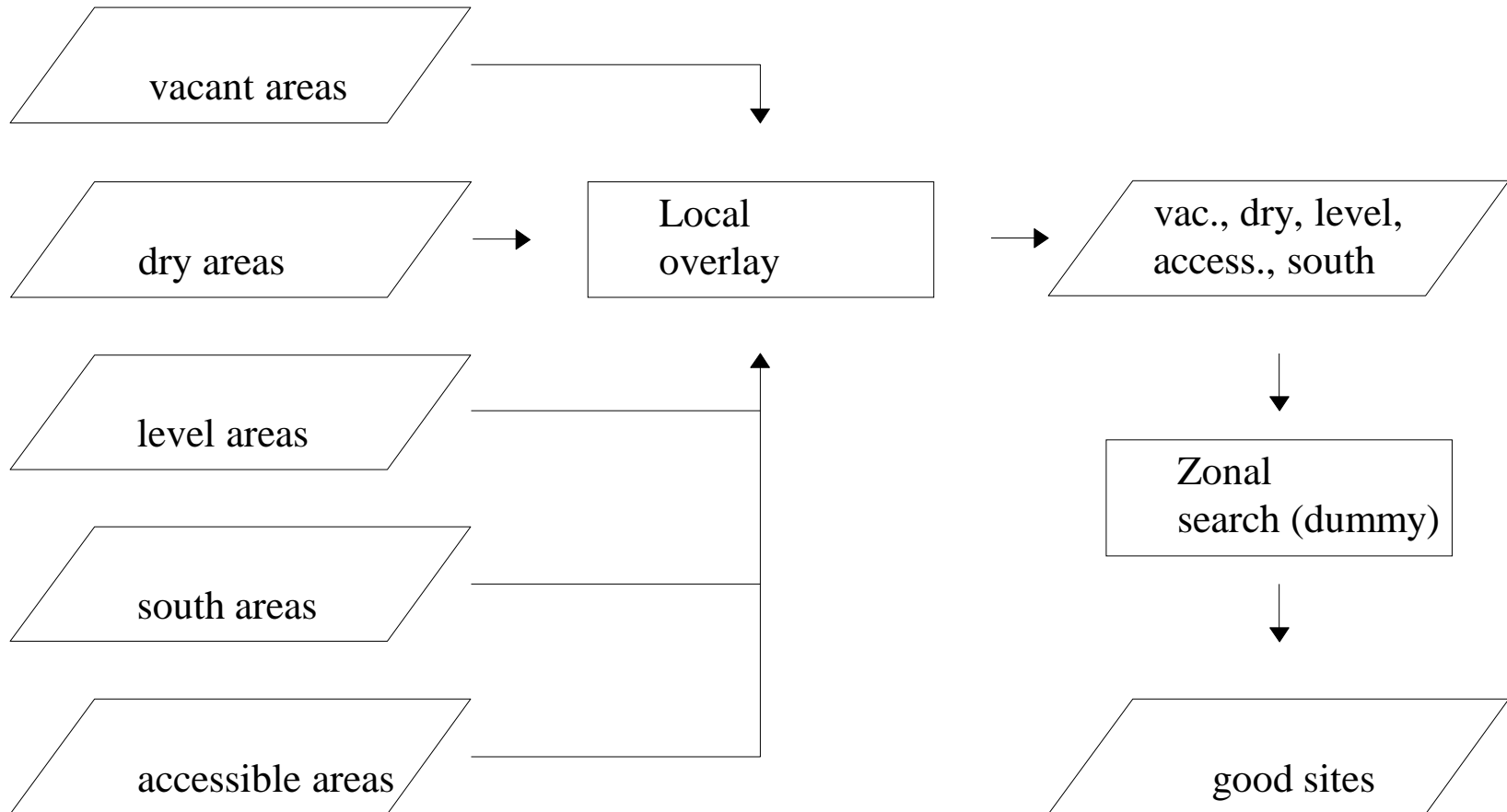
Example...

(5) Find accessible areas (road net)...



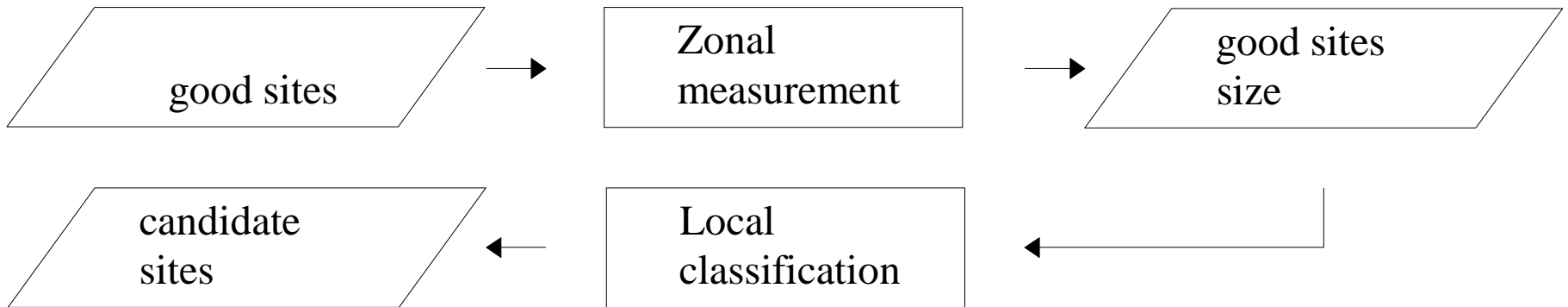
Example...

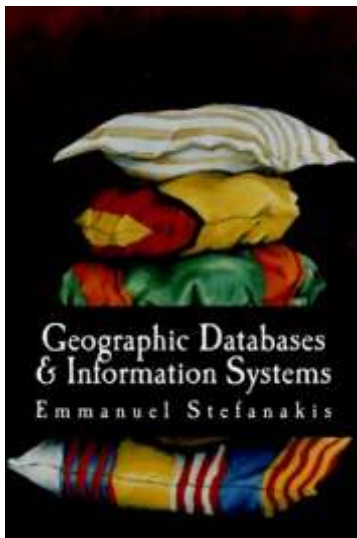
(6) Highlight the 'good' sites...



Example...

(7) The Solution ...





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