Institut für Informationssysteme
Technische Universität Braunschweig

Technische Universität Braunschweig
Institut für Informationssysteme
http://www.ifis.cs.tu-bs.de

Karl Neumann, Sarah Tauscher

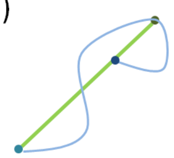
Spatial Databases and GIS

Solutions for Sheet I

Exercise 1 (9-intersection model)

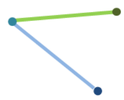
1. Draw two simple lines to exemplify the given 9-intersection matrices.

a)



$$\begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix} \end{array}$$

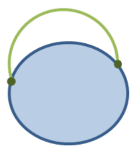
b)



$$\begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$

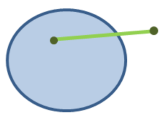
2. Write down the matrices for the topological relations between the drawn geometries.

a)



$$\begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{pmatrix} \end{array}$$

b)



$$\begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 1 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$

3. How many different topological relations are possible between the following geometries? Why?
   a. two points
   A point has no border, i.e. the corresponding entries are always 0. As the interior only consists of one point, there can only be one intersection for each interior, i.e. either the interiors intersect or the interiors intersect with the exterior. The exteriors of two points always intersect. Consequently there are only two possible matrices:

$$\begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} \end{array} \qquad \begin{array}{cc} & \begin{matrix} I & B & E \end{matrix} \\ \begin{matrix} I \\ B \\ E \end{matrix} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{pmatrix} \end{array}$$

Technische Universität Braunschweig
Institut für Informationssysteme
http://www.ifis.cs.tu-bs.de

Karl Neumann, Sarah Tauscher

b. a point and a line

The considerations of a) are also true for this case, i.e. the entries for the boundary of the point are 0, but there are three possibilities for intersections with the interior of the point. There are always intersections between the exterior of a point and the boundary, interior and the exterior of a line, as they consist of more than one point. Consequently there are three possible matrices:

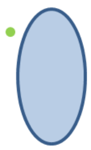
$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$

$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$

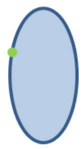
$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$

c. a point and a polygon

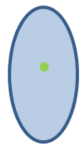
There are also three possible matrices for the same reasons as in b):



$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 1 \\ 1 & 0 & 1 \end{pmatrix} \end{array}$$



$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 1 \\ 0 & 0 & 1 \end{pmatrix} \end{array}$$

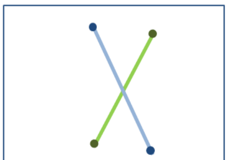


$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 1 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 1 & 1 \end{pmatrix} \end{array}$$

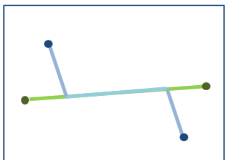
4. Can you think of topological relations, having the same 9i-matrix, although you might consider them to be different?

   The number and the geometry of the intersection(s) are not considered, although it might be relevant. E.g. if the blue line is a cycle way and the green line a busy road.

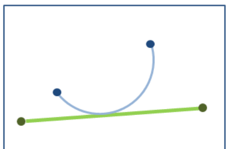
$$\begin{array}{cc} & \begin{array}{ccc} I & B & E \end{array} \\ \begin{array}{c} I \\ B \\ E \end{array} & \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \end{array}$$



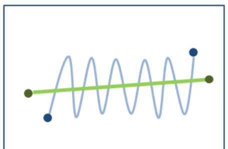
point in common



line in common



no change of sides

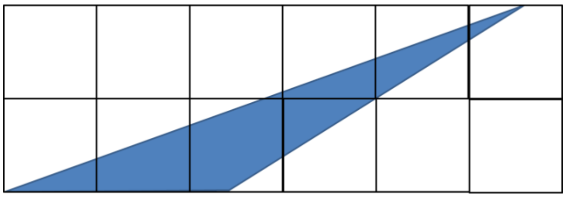


many intersections

Karl Neumann, Sarah Tauscher

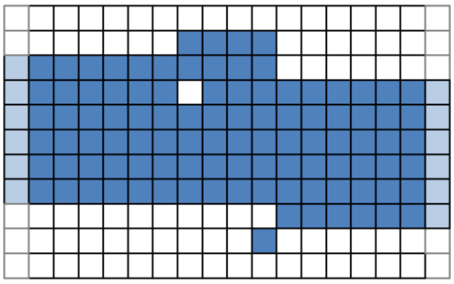
Exercise 2 (Rasterization)

1. How can you determine the raster-width you need to represent a given vector polygon accurately in that raster?
   Order the x-coordinates in one list and the y-coordinate in another, determine the smallest difference (> 0) between two coordinates and take half of that value (sampling theorem).
   a. What is the complexity of the calculation of the raster-width?
      O(n log(n)), because you have to sort the values.
   b. Will it work for all polygons? Give examples of problematic polygons if they exist.
      No, it will only work if the points are only connected by straight lines. Polygons with acute angles and long edges can be problematic, e.g.:

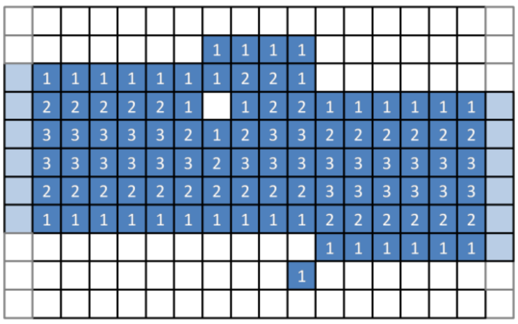


Exercise 3 (Centerline extraction)

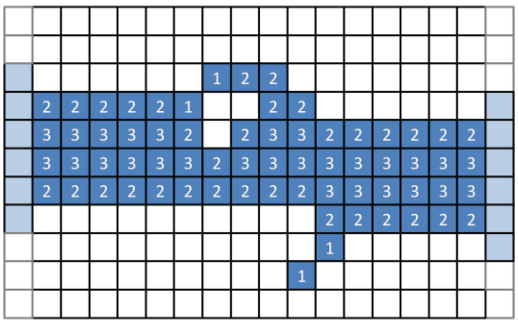
1. Vectorize the dark blue part of the given line using topological thinning. The light blue pixels only show how the line continues.



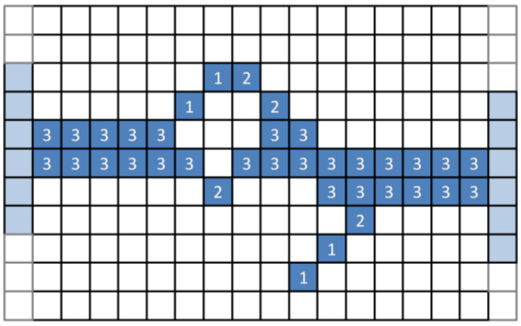
   a. *Determine for each line pixel the distance to the next white pixel*



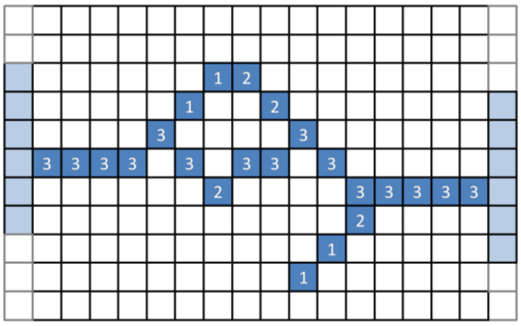
   b. *Delete all insignificant pixels with distance 1*



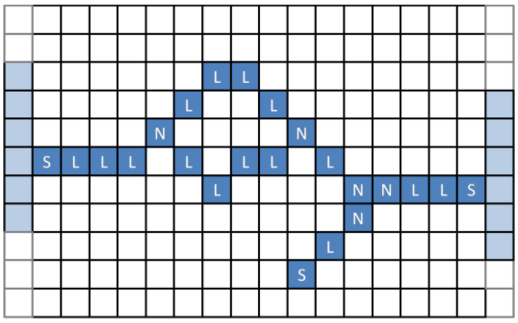
c. *Delete all insignificant pixels with distance 2*



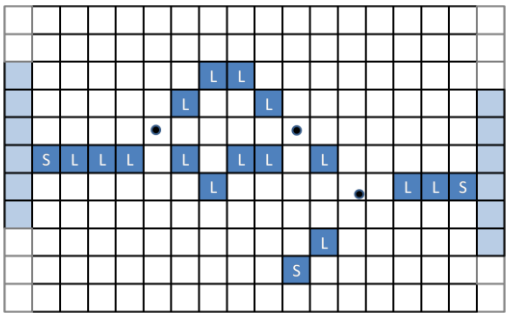
d. *Delete all insignificant pixels with distance 3*



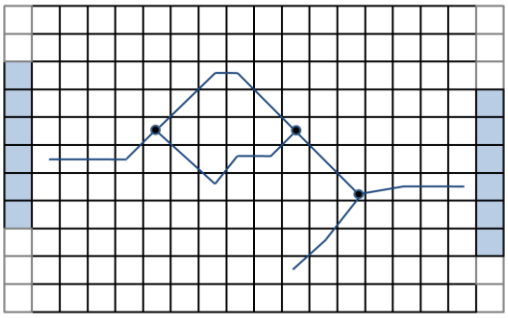
e. *Classify remaining pixels*



f. *Determine centroid of connected node pixels*



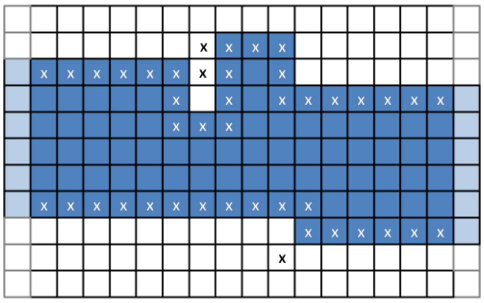
g. *Draw line*



Karl Neumann, Sarah Tauscher

2. If holes and stubbles consisting of only a few pixels are most probably faults, what could be used as preprocessing step to eliminate them?

Erosion+Dilatation → eliminate stubbles



Dilatation+Erosion → close holes