IDENTIFICATION OF LINEAMENTS ON THE BASIS OF POINT PHENOMENA – MATHEMATICAL MODEL

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Abstract

This paper contains preliminary results of our research, aimed at creating an algorithm, which will find parameters of lines (lineaments) on the basis of a set of points (springs) with known position (known coordinates X and Y). The algorithm can be used in a geographic information system for analysis of geographic data.

1 Introduction

In general, the concept of lineament is understood as a characteristic linear formation. Within the context of geology and geomorphology, a dislocation is usually meant. Identification of lineaments is currently performed most often by remote sensing methods. Another possible approach is the usage of accompanying point phenomena, for example springs. In this case, the position of point phenomena is represented in a map and the expected courses of lineaments are then empirically identified.

2 Solution

Searching for a single lineament would mean trivial finding of an analogy of a regression line. However, the calculation is complicated by the fact that the number of lines is not known in advance.

A basic algorithm able to determine the number of lineaments, divide a set to subsets corresponding to individual lineaments, and calculate the lineament parameters was developed using a combination of methods from different fields of mathematics and geostatistics. The calculation procedure was implemented and verified using the MATLAB software.

Procedure:

a) For an input set of points (Fig. 1), the directions of abscissae, defined by all the pairs of points, are calculated (Fig. 2). The directions are calculated within the range (0°, 180°>.

b) Creation of direction histograms (Fig. 3). The local maxima of the histogram characterize the directions of point clusters. The number of local maxima specifies the number of lineaments. The advantage of the histogram approach is its simple construction; the disadvantage is the unclear position of the maximum, which is given only as an interval.

c) In order to specify the directions of lineaments more precisely, creation of frequency curve using sum of individual curves is used (Fig. 4). Triangle distribution was used in order to achieve simplification of the calculation. The positions of local maxima on the x axis define first approximations of the directions of lineaments (Fig. 5).

d) The division of the set of points to subsets corresponding to individual lineaments. Methods of cluster analysis were used. None of the existing methods works with the line cluster, therefore a modified version of the K-means algorithm was used. A parameter of the method is the distance of a point from a line of a given direction. The method divides the original set of points to subsets corresponding to individual lineaments.

e) Calculation of regression lines for subsets of points. These lines are the searched lineaments (Fig. 6).

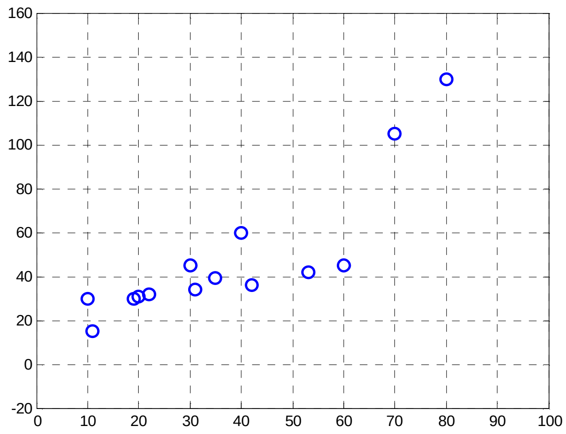

Fig. 1: Input set of points.

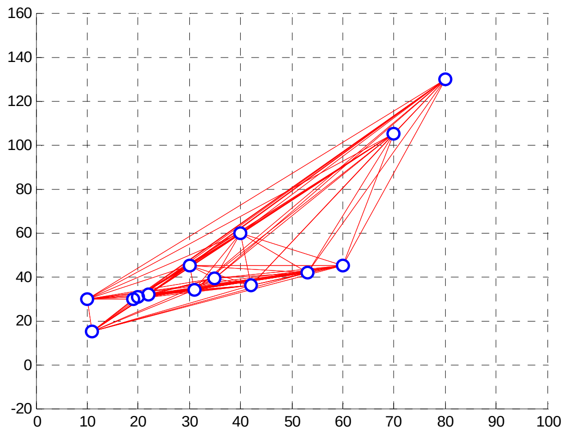

Fig. 2: Abscissae for all point pairs.

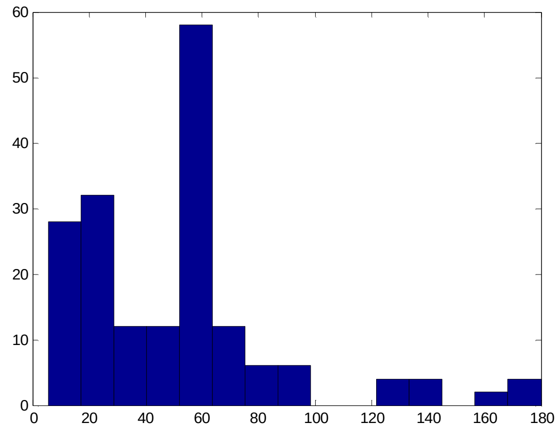

Fig. 3: Histogram of line directions.

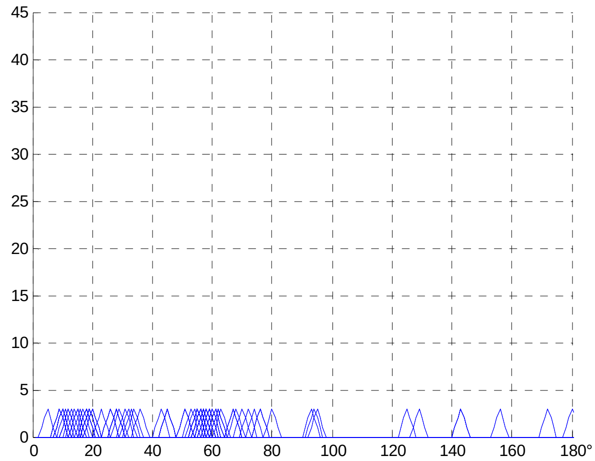

Fig. 4: Triangular distributions corresponding to individual directions.

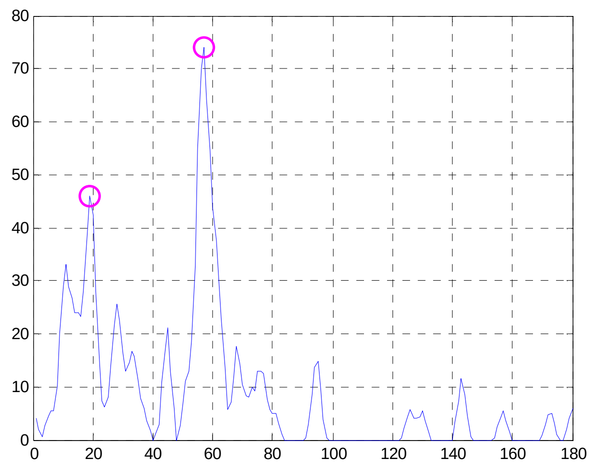

Fig. 5: Sum of triangular distributions.

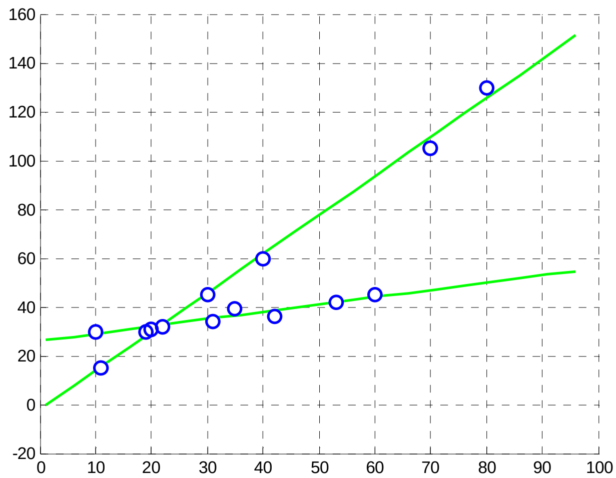

Fig. 6: Resulting lines/lineaments.

3 Conclusions

Current algorithm allows us to find solution for standard point configurations. However, two groups of issues have not been solved yet. The first is the situation of two or more parallel lineaments. The second is the allocation of points to individual lineaments in the place of their crossing. The points are currently assigned only to the closest line, but this procedure is not completely convenient.

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