SIMULATION OF THE BEHAVIOR OF LOCAL EXTREMA IN THE DISTRIBUTION

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Abstract

Distribution chains can change their parameters. There are changes in the final quantity and the final destinations too. This paper deals with searching of local maxima. There is analysis of the quantity of goods delivered to customers in time and space. We have simulated distribution of selected goods in the segment of specific pharmacies. We have recorded information about capacity of the deliveries according to the time and customers. It was evaluated distribution of the amount of delivered goods. There are using the precedent matrix to found places with larger supplies than the immediate surroundings. We have monitored the changes of maxima and their distribution of in space and time. There were also analyzed dependencies in this distribution of maxima. We have used the method of precedents matrices and we compared the results with the simulation based on the Simul8 program. Results can be used for the allocation of vehicles on the basis of knowledge of the behavior of the distribution. The benefit is that the simulation is performed on a specific real business process.

Keywords: Simulation, distribution, precedence, model

1. INTRODUCTION

Methods of analysis of flow variables are quite often used, especially in logistics systems. In the context of modelling and simulation is a priority choice and design of infrastructure, then the analysis of the motion of the observed bodies after this infrastructure. The most commonly used methods include distribution problems of linear programming, especially transportation problem, assignment problem, the problem of circle transport and general distribution problem, Research in this area were carried out in the context of major infrastructure projects (in the CR example BBMRI, CESNET, CzechCOS / ICOS, CzechGeo / EPOS, CzechPolar, CZERA, ESS, ESS - survey etc.). The claimed methods are particularly concerned with monitoring the absolute values (quantity of distributed entities, the duration of activities) and statistical processing. The paper deals with an innovative approach, analyzed the changes are monitored, thus are the dips and rises in the variables of space and time. The claimed methods have been presented in the past such as [6] or [7]. The method is applied to a specific subsystem of the distribution process of the selected portfolio of products the pharmaceutical companies and pharmacies in selected municipalities of the CR.

1.1. Distribution chains

The starting point for the analysis is a distribution logistics, that is support in the implementation of the decisions of the summary tasks and measures for the preparation and execution of the distribution. Whereas the role of distribution logistics is to provide manufactured goods as defined per the type, the quantity of space and time so that they can be either complied with specified delivery time, or that it could be possible, most successfully met the expected demand, deals with the analysis of distributed product quantity as a factor of demand prediction.

1.2. Research, the research question, hypothesis, scientific goal

Priority objective of the distribution is therefore satisfying the demand. In this context, the emerging research questions. Is there a time dependency between the local extrema in the distribution traceable on a specific timeline? The spatial movements of local extremes can be mathematically describable? You can use a mathematical model and simulation of the program to predict future demand? Of these questions and the distribution of the objectives of the research goal resulted to create a model for tracking the extremes, to model a specific behavior of an existing distribution process and identify the dependencies. The extremes have been studied the distribution process, such as extreme was marked with the pharmacy, in which delivery was higher than in the surrounding pharmacies, available through the distribution infrastructure. In this context, have been made the hypothesis that deliveries to individual pharmacies characterized as extreme are cyclically dependent over time, this means that in time the position of the extreme moves by using a distribution function.

2. PROCEDURE, MODEL, METHODOLOGY

To answer questions and confirmation of the hypothesis was defined a distribution infrastructure. It was created by the model that defines the minimum distance between the monitored nodes. The model was defined as a generic, enabling the definition of any of the network based on real physical infrastructure (transport distance, network bandwidth, transport capacity, etc.) or a virtual infrastructure (defined based on the availability and accessibility of using geographical location, regardless of the physical infrastructure). The criterion is to create a contiguous infrastructure with "sufficient" density based on defined criteria. For creating the infrastructure has been used multiagent system. Custom modelling infrastructure is made up of a search based on the geographical coordinates of lows, for each node (end node distribution chain pharmacy) is based on a random passage network to find the nearest "appropriate" around. The model allows you to search a predefined number of bindings. The model also allows resolution of found links between points A and B in terms of the orientation of the AB or BA. To ensure an even distribution of links can be supplemented with an infrastructure based on triangulation, to ensure the continuous system can be used as the default infrastructure minimal skeleton. Infrastructure is further optimized by repeated passes. Infrastructure is recorded by incidental binary matrices. For a defined infrastructure to further model compare values of specified factors. Based on the values of the factors are determined the directions of increase or decrease the tracked variables. Changes are tracked between consecutive elements on a defined infrastructure. This leads to the creation of the infrastructure-oriented, are used to capture the case matrix (matrix precedential). For modelling and simulation has been used software MS Excel.

2.1. The data distribution infrastructure

Data used for the analysis of the distribution of specific companies in the period up to February 2015 July 2016. The data file contained almost 6500 records of more than 1200 pharmacies in about 550 villages. Were 55 products portfolios. The time scale was one day. In the context of data inconsistencies, it was necessary to simplify the model, for the initial research were as endpoints defined in the distribution chain of the municipality, not the pharmacy. Referenced post summarizes daily distribution to monthly intervals.

2.2. Modeling of the infrastructure, the selected models, the description of the method

Infrastructure has been defined for the village with the localization of registered pharmacies. For the village in pharmacy data were summarized (in the case of dislocation more pharmacies in the village). For the selection of the village was selected as a criterion for the zip code (there are more municipalities with the same ZIP CODE but also the municipality with more zip).

Table 1 illustrates parsed sequentially models of infrastructure. In the left column is the infrastructure created 10 cycles, 3 edges are defined, uniform distribution is secured by Triangulating the bindings, the edge of BA is not identical with the edge AB. Generating it took 5 hours 42 minutes. In the first row are captured by the identification of links, green is binding with the identification of 10 percent, then the red with the identification of 100 percent. In other rows is then defined by the infrastructure when 90 percent and 100 percent of passes. The right column then shows simpler models, when either is not required of triangulation, the edge AB is understood as a BA or the accuracy of the model is limited to a smaller number of passes. Black and white structures are 100 percent records identified, color model once again distinguishes the appropriate percentage of the identification.

2.3. Simulation, precedence, changing local extremes

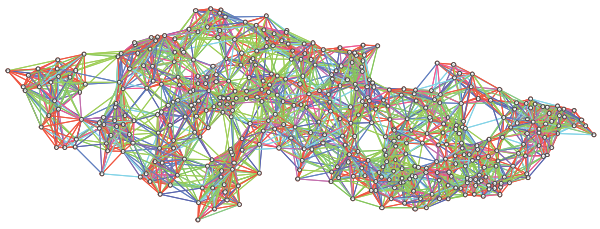
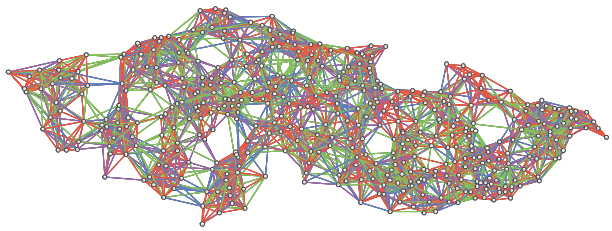
For the determination of local extremes has been used a model defining the 3 edges, 10 cycles, triangles, edges enabled the calculation of the looping lasted 2 hours 57 minutes. The structure has an acceptable density, the model is continuous, the edges were 100 percent identified. For each of the nodes (modified end points of distribution) were compared using the first precedence (more about the method e.g. [6]) distributed a summary value range. **Table 2** shows the selected infrastructure of the CZECH REPUBLIC and in red marked the first precedence - local maxima - in the period of May 2016. The next cell of **Table 2** show for demonstration of selected segment of the municipalities and the movement of the extremes in your watch months (presentation segment is determined by the scope of the contribution; the comparison of the entire infrastructure would not be unreadable). The red circles indicate the extremes, the Red arrows indicate links between adjacent nodes on which delivery occurred, however, it is less than the value in the extreme. In the selected segment are shown municipalities - see **Table 4**.

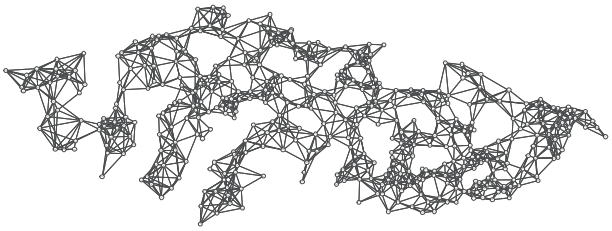
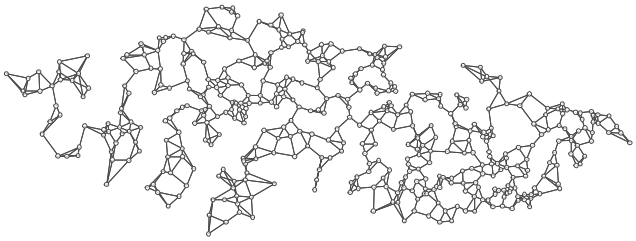
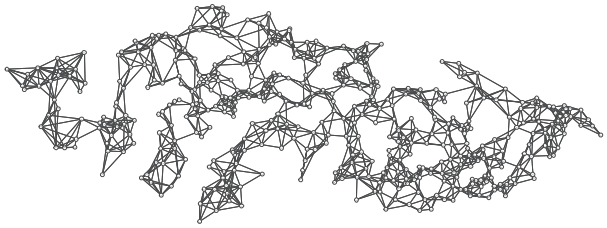
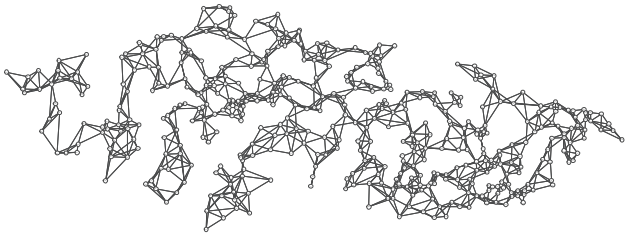
Table 3 shows the then-year comparison in models with different density infrastructure. For a demonstration of the expanded selection is displayed, the area that is shown in **Table 2** is highlighted in this area shading.

3. DISCUSSION - EVALUATION OF METHODS, EVALUATION OF A SPECIFIC MODEL OF RESEARCH, RECOMMENDATIONS

Method and model provides an accurate picture of the distribution of the local maxim. In a similar way, you can identify local minima. Based on the multiplication of matrices (closer to the case e.g. [6]) can be identified increases or declines in the distributed product quantity between the end points of distribution in the larger distances, not only between neighboring points.

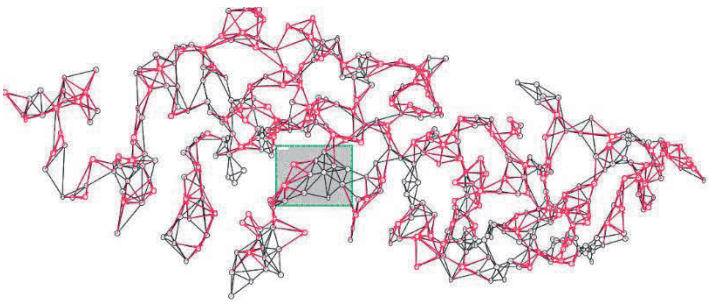
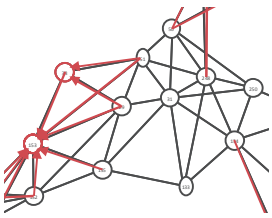
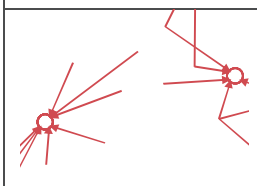
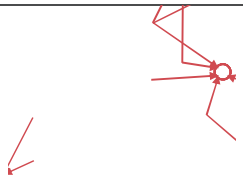
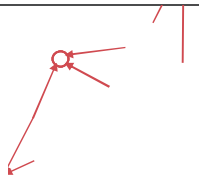
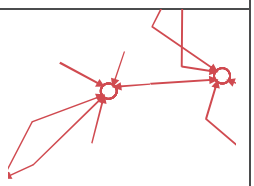
Table 1 Different density distribution infrastructure

	
10 cycles, 3 edges, triangles yes, no repeat, 5 hours 42 minutes	4 cycles, 3 edges, triangles, without overwriting the edges

	
10 cycles, 3 edges, triangles yes, no repeat, 90 percent or more of identification	10 cycles, 3 edges, transcription is enabled, without triangles
	
10 cycles, 3 edges, triangles yes, repeat no, 100 percent identification	3 edges, 10 cycles, triangles yes, looping edges allowed, 2 hours 57 minutes

Model to further assess the real distances that can be identified for example. based on the length of the road network. The model also allows defining the capacity options, not limited by distinguishing the level of transport infrastructure (limited processing power of the computer). The versatility of the model has been proven not only for modelling distribution channels but also in manufacturing processes and systems modelling and regional analyses.

Table 2 Local extremes - development in months

				
Simulated infrastructure - modeling precedence			Selection of distribution. May 2016	
				
February 2015	March 2015	April 2015	May 2015	June 2015

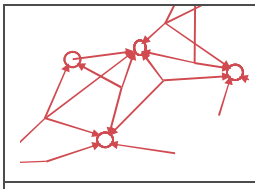
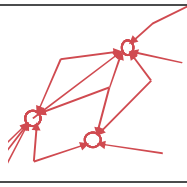
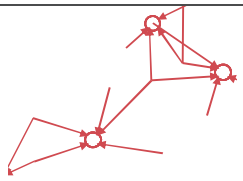
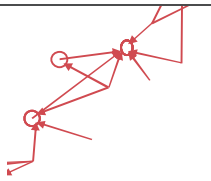
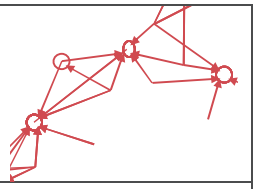
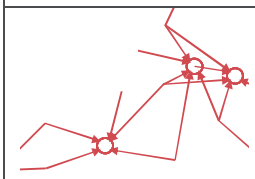
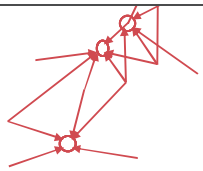
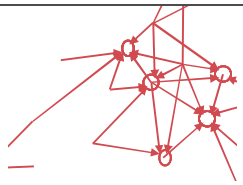
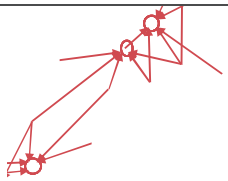
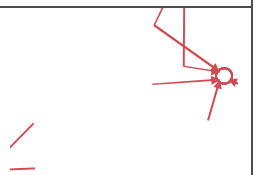
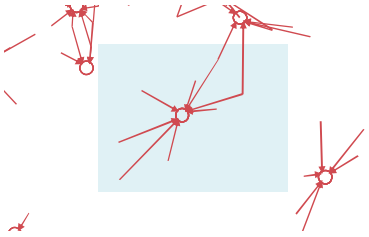
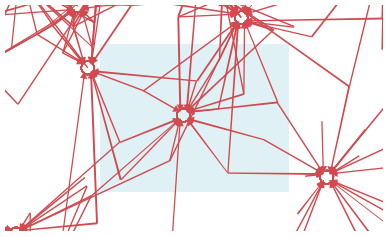
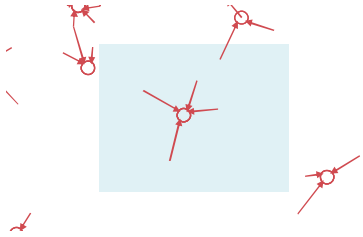
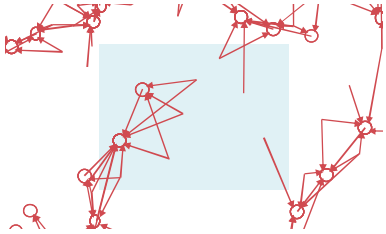
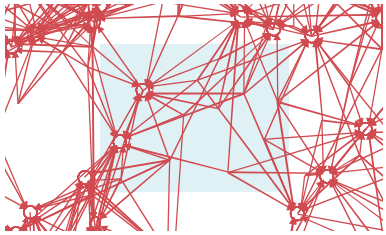
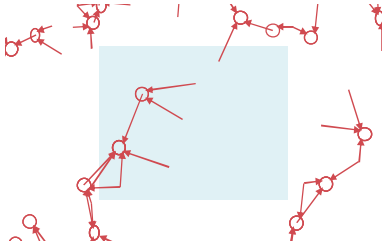
				
July 2015	August 2015	September 2015	October 2015	November 2015
				
December 2015	January 2016	February 2016	March 2016	April 2016

Table 3 Local extremes - different density infrastructure-year comparison

		
May 2015 - variant 1 100 percent	May 2015 - variant 2 -100 percent	May 2015 - variant 3 -100 percent
		
May 2016 - variant 1 all	May 2016 - variant 2 all	May 2016 - variant 3 all

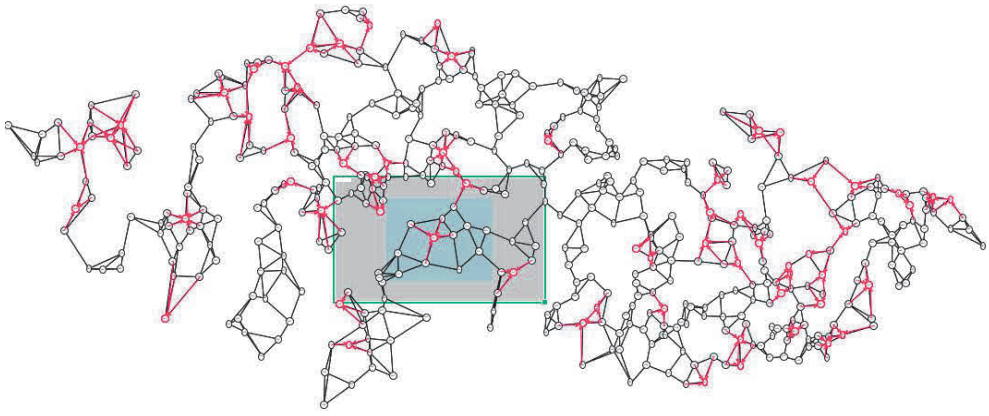


Figure 1 Local extremes - the segment for comparison

Whereas, in this phase of the research were not examined other factors for example the absolute value of the supplies, cannot be in the present define dependencies. Not found clear distribution function applicable to simulate the Simul8 simulation program, it was not possible at this stage of the research predict the distribution. Similar research abroad (exploring the circularity in the economic phenomena, respectively. in the distribution) recommend tracking statistics quantities, layout, slope, and so on, which recommends for example: When the examination of the impact of cyclical wage model and the efficiency of Park and Choi [2] at the same time influence is debated monetary and fiscal instruments to the behavior of the market, which may significantly affect the fuel consumption and thus also distribution, regarding the cyclicality of the use of these tools. Circular and cyclical factors specify for example Strawczynski [3].

Further, as points out for example. Sosa et al. [4] would be similar research should consider the analyses related to the distribution and qualitative factors.

Table 4 Extreme and Precedence

code	village	extreme															precedence													
		February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May
29	Čechtice				1	1												1		1			1	1	1	1	1	1	1	1		1
31	D. Kralovice													1				1	1		1		1		1	1	1	1	1		1	1	
33	Vlašim			1			1			1	1						1	1			1	1		1					1	1	1		
50	Zbraslavice								1				1		1			1	1		1	1	1	1		1	1	1		1		1	1
51	Zruč n. S						1	1		1	1		1	1	1			1		1	1	1		1	1			1					1
133	Pelhřimov													1									1	1	1			1	1				
134	Humpolec													1				1	1			1	1		1		1	1				1	1
135	Pacov						1	1	1			1	1					1			1	1				1	1			1	1		1
152	Chýnov														1			1	1	1	1	1	1	1		1	1	1	1	1		1	1
153	Ml. Vožice	1						1		1	1						1		1		1	1	1		1			1	1	1	1	1	
248	Ledeč n. S											1						1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
250	Světlá n. S	1	1			1	1		1		1	1		1		1				1									1		1		

4. CONCLUSION

Not found a clear answer to the research question, whether there is a time-dependency between the local extrema in the distribution, traceable to a specific timeline. It can be stated, that have been identified the end of the distribution chains, returning a low frequency of extremes and low frequency of deliveries, while these extremes do not depend on the number of the population in the region (Pelhřimov, 1 extreme x delivery). Additionally, you can identify the end of distribution chains, which have a very low the frequency of extremes, but have a high density of the supply of goods (Chýnov, Ledeč nad Sázavou, 1 extreme, supplies almost every month). Distribution It shows seasonal fluctuations, however, does not copy the character of the seasons, vacations or holidays (such as fluctuations in the months of April, May).

Can be traced from the geological occurrence of extremes (Vlašim, Zruč nad Sázavou, Světlá nad Sázavou, etc.), but differs in the cyclicality of the endpoints Per the capacity of supply. Can be traced back for changes the direction of cyclicality (for example, precedence. Humpolec, Pacov). The annual changes to show an increase in the density of links, fail to conform distribution of endpoints fail to conform the direction precedence. Year on year comparison shows the conformity in the occurrence of extremes and precedence. Increase the density of the network does not lead to the identification of new extremes, only identifies the new binding, as shown in **Table 3** - comparison of interannually increases the selected segment.

The research objective, to create a model for tracking the extremes, model the specific behavior of an existing distribution process, and to identify addiction has been satisfied, the model is a flexible, extensible, model was used in the analysis of the distribution of the drug companies. On the specific the case has been partially confirmed the hypothesis that the supply to the individual pharmacies, characterized as extreme, are cyclically dependent, in time This means that in time moves the position of the extreme of using distribution function. This distribution function, however, failed to find. Of the previously mentioned studies for finding the distribution you need to consider the wider context, at the same time but the question further research, whether in the long run proves referenced model percentage sufficient results. In this context, as appropriate appears to be a possible extension of the stochastic method. Similar extensions are used, for example, in the model of real-business-cycle as such Andolfatto [5].

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