UDC 656.13

TIME SERIES OF TRAFFIC INTERVALS BETWEEN VEHICLES ON THE MAIN STREET IN SOFTWARE R

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The goal is to investigate time series of traffic intervals between vehicles on the main street under different conditions within one week and try to predict the intervals between vehicles for the future. To accomplish this goal it is decided to apply the modern computer Software R.

Drivers should have increased attention and good concentration during driving a vehicle in a dense traffic flow [1]. Driving in such flow a lot depends on the driver of the vehicle that is moving in front (–driver-leader"). Under such conditions, the visibility of the lane in front of the –car-leader" is limited. Therefore, the driver who moves behind is much more difficult to predict in advance the reasons for a possible decrease in speed or even an emergency stop of the car. The greatest danger in these conditions is the movement along the main streets, especially at the moment of acceleration at a distance of 50-100 meters behind the regulated intersection [1, 2].

Taking into account, the study of time series of intervals between vehicles in the traffic flow was carried out on one of the streets of Lviv, which is regulated by traffic lights with a dividing line in a period from Monday to Friday. In that street, the intensity of the traffic flow is in the range from 900 to 1200 veh/h and the average share of passenger cars - 80%.

Time series research was conducted using video, covering two lanes in one direction. The values of time series of traffic intervals between vehicles are received for each day of the week [3].

At the first stage a database of time series of intervals was downloaded into Software R [4]. Software R is a free software environment for statistical computing and graphics. It is recommend to use Software R with RStudio. Installing and run Software R:

- download and install Software R [4];
- run Software R and open Package –fpp2";
- use command TV=scan("clipboard",sep=",") without push –Enter". Copy the data of distance time (TV). Return to R and click –Enter". The data should be loaded. To watch them: ts.plot(TV).

The time series of traffic intervals consists of 164 values for each day of the week (in the morning). To build a data time series in Software R use functions [1-3]:

ts.TV=ts(TV,frequency=164, start=c(0,1)); (1)

plot(ts.TV, ylab="Distance Time [Miliseconds]"); (2)

where frequency – the number of observations per unit of time; start – the time of the first observation; ylab =Y axis label.

Based on these functions in Software R, the dependence –traffic intervals between vehicles – number of days" displayed graphically (Fig. 1).

At the next stage it is carried out Decomposition STL – Decompose a time series into seasonal, trend and irregular components using loess, acronym STL [5]:

stl.TV=stl(ts.TV, t.window=164, s.window="periodic", robust=TRUE). (2)

wherer t.window – the span (in lags) of the loess window for trend extraction, which should be odd; s.window – either the character string ―periodic" or the span (in lags) of the loess window for seasonal extraction. This has no default; robust – logical indicating if robust fitting be used in the loess procedure.

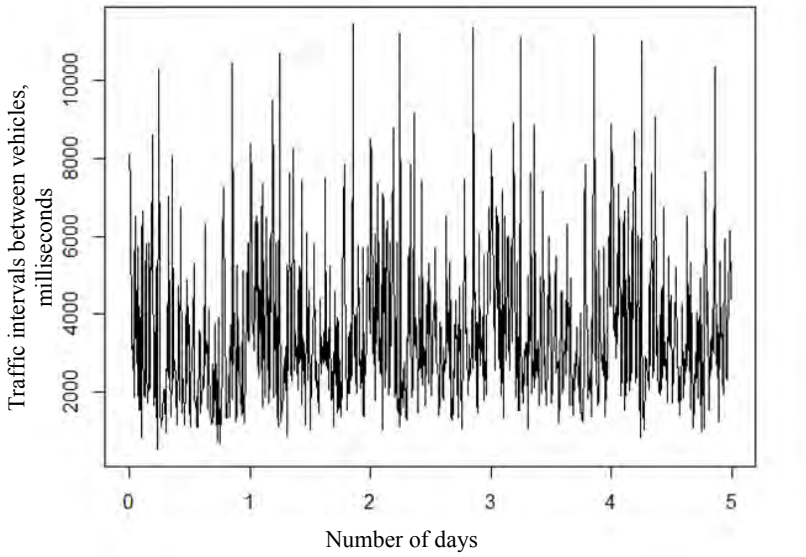


Fig. 1. Traffic intervals between vehicles – number of days

Decomposition STL is used for forecasting of time series of traffic intervals between vehicles for the future period. The results of determining the components of the decomposition STL are shown in Fig. 2.

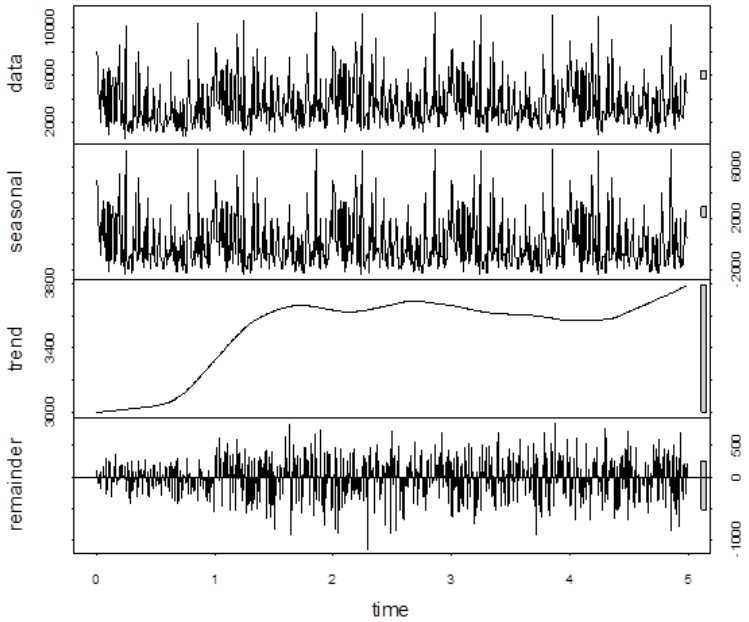
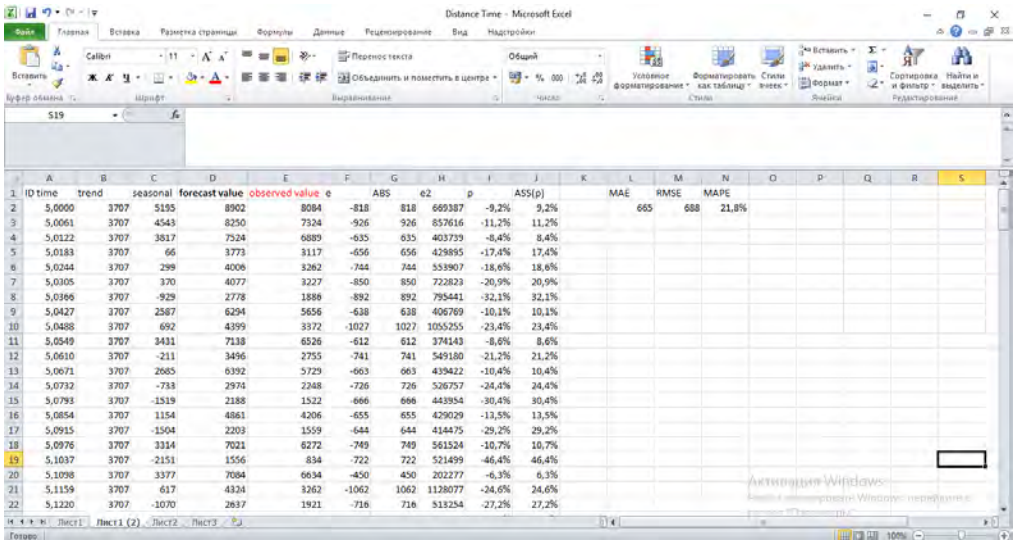


Fig. 2. Decomposition STL of time series in Software R for all periods

To check the results of forecasting, the values (obtained during the decomposition STL of time series) from Software R is transferred to Microsoft Excel (Fig. 3).

Using the trend and the seasonal variable, we can get the predicted result of the time series of vehicle intervals in a certain period. For an example in Microsoft Excel, the forecast is scheduled for the next business day, Monday.

When comparing the obtained values with the existing, the average error is defined in milliseconds and percentages. As a result it is defined indicators such as: MAE (Mean Absolute Error), RMSE (Root Mean Square Error) and MAPE (Mean Absolute Percentage Error).



ID time	trend	seasonal	forecast value	observed value	e	ABS	e2	p	ASS(p)	MAE	RMSE	MAPE
5,0000	3707	5195	8902	8084	-818	818	669387	-9,2%	9,2%	665	688	21,8%
5,0061	3707	4543	8250	7324	-926	926	857616	-11,2%	11,2%			
5,0122	3707	3817	7524	6889	-635	635	403739	-8,4%	8,4%			
5,0183	3707	66	3773	3117	-656	656	429895	-17,4%	17,4%			
5,0244	3707	299	4006	3262	-744	744	553907	-18,6%	18,6%			
5,0305	3707	370	4077	3227	-850	850	722823	-20,9%	20,9%			
5,0366	3707	-929	2778	1886	-892	892	795441	-32,1%	32,1%			
5,0427	3707	2587	6294	5656	-638	638	406769	-10,1%	10,1%			
5,0488	3707	692	4399	3372	-1027	1027	1055255	-23,4%	23,4%			
5,0549	3707	3431	7138	6526	-612	612	374143	-8,6%	8,6%			
5,0610	3707	-211	3496	2755	-741	741	549180	-21,2%	21,2%			
5,0671	3707	2685	6392	5729	-663	663	439422	-10,4%	10,4%			
5,0732	3707	-733	2974	2248	-726	726	526757	-24,4%	24,4%			
5,0793	3707	-1519	2188	1522	-666	666	443954	-30,4%	30,4%			
5,0854	3707	1154	4861	4206	-655	655	429029	-13,5%	13,5%			
5,0915	3707	-1504	2203	1559	-644	644	414475	-29,2%	29,2%			
5,0976	3707	3314	7021	6272	-749	749	561524	-10,7%	10,7%			
5,1037	3707	-2151	1556	834	-722	722	521499	-46,4%	46,4%			
5,1098	3707	3377	7084	6634	-450	450	202277	-6,3%	6,3%			
5,1159	3707	617	4324	3262	-1062	1062	1128077	-24,6%	24,6%			
5,1220	3707	-1070	2637	1921	-716	716	513254	-27,2%	27,2%			

Fig. 3. Transferring the results of the forecasting from Software R to Microsoft Excel

It is determined that MAE is 665 milliseconds, RMSE - 21.8%, MAPE – 688 milliseconds. The results of forecasting can also be estimated using the graph (Fig. 4).

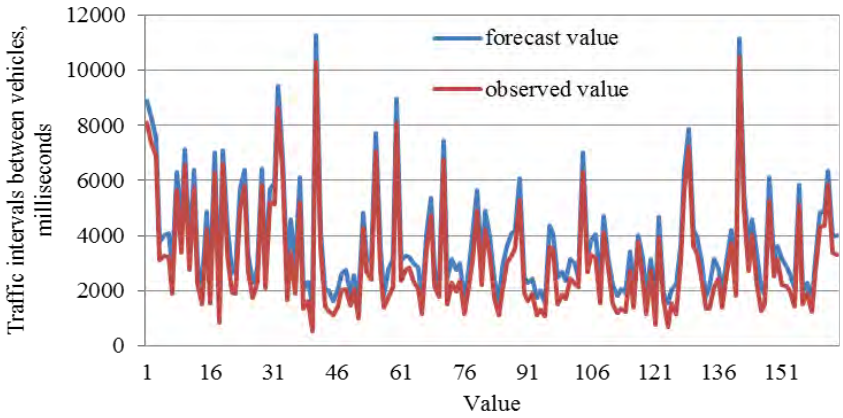


Fig. 4. Comparison of predicted and existing values of time series of traffic intervals between vehicles

On the basis of the obtained data it is possible to make next conclusions:

- in the data there is a pronounced dependence on the days of the week;
- the chosen model for predicting time series is fairly accurate, since the average error is 21%.

The proposed model is universal and self-regulated. To improve the forecast, it is necessary to continue collecting data and refining the model. As more data the better is forecast.

Knowing the predicted intervals between vehicles, we can determine how much traffic, density, dynamic size and speed. Since these indicators are dependent.

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