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COMPARISON OF ARRIVAL MODELS IN THE CONTEXT OF URBAN TRANSPORT

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ABSTRACT

The process of modeling a random process requires a careful analysis and a correct interpretation of the behavior of the process. In different contexts, different statistical distributions may be eligible for the same model obtained in the study. In response to this situation created quite often in practice, we make use of statistical analysis methods to make possible comparison and decision making regarding the selection of the most appropriate model. In our study the usage of such methods is illustrated by comparing two of models commonly mentioned in literature when it comes to bus headway times modeling. Models under consideration are Gaussian model and Poisson model. To evaluate the performance of these models visual and analytical methods are used in this study. The simulation of these processes is made possible using the power of R language. Although both models have their practicability in a certain degree, tests showed that the Gaussian model fits best with the real model.

JEL CLASSIFICATION & KEYWORDS

■ C02 ■ C15 ■ C13 ■ RANDOM PROCESS ■ GAUSSIAN ■ POISSON ■ MODELLING

INTRODUCTION

Bus headways are a very important concept in the theory of urban transport modeling. Time between two successive arrivals of buses is bus movement time minus the time the bus spends at the station. This depends on the speed of the bus, traffic, street, random delays, etc.

So we can think of the interval between two successive arrivals bus as a random variable and mark them with T_i.

Accurate modeling of this random variable helps toward a greater regularity in urban transport and minimizes the waiting time for passengers at the station.

In the literature there are a number of models for variable T_i. In the study (Raço, 2012) a Gaussian model was created, which assumes a normal distribution assumed for T_i. There are also other studies (E.Akchelik, R. Chung, 1994) where instead of Gaussian models to model T_i an exponential distribution is assumed.

In our study we take usage of statistical methods to compare two of commonly mentioned models in the literature when it comes to headway times modeling. Distributions under consideration are normal and exponential.

Comparison of models and analysis

To make possible the comparison of models we consider the following steps:

- Data were collected through direct observations at the station.
- Assessment of distribution parameters for both models based on the data collected. Evaluation of parameters is performed using the method of moments (MM) and maximum likelihood estimation method (MLE).
- Computer simulation of processes was done using estimated parameters for distributions.
- Simulated processes are presented graphically and T test was performed for both distributions to make comparison possible.

Data collection through direct observations at the bus station was performed during peak hour 7:00 to 9:00. The methodology followed for the collection of these data is treated in the study (Raço, 2012). Measurements are spread over a week, in the intervals mentioned above. Measurements were not performed during weekends (Saturday - Sunday) because regime of urban system in these days is different from the weekdays.

Evaluation of parameters is a very common procedure in statistics when it comes to the problem of finding the model that matches the real process. When we have a population that we believe comes from a specific distribution, we must find the values of the parameters for this distribution in order to present the data in a correct way (Leka, 2004).

There are various methods such as numerical and graphical, to estimate the parameters for a probability distribution. For the evaluation of the parameters in our study only two methods will be considered: method of moments (MM) and method of maximum likelihood (MLE).

A more detailed description on the usage of MLE and MM to evaluate the parameters of the distributions can be found in (B.R.Millar, 2011).

For the exponential distribution we have estimated value of parameter (Leka, 2004).

$$\tilde{\lambda} = 3.77$$

For normal distribution we have estimated values of parameters:

$\sigma^2 = 3.085$ $\mu = 5.43$

Using the estimated parameters we simulate the processes using algorithm described in (Raghu, 2011) for Poisson model and the algorithm described in (Law M.A, Kelton D.W, 2000) for the Gaussian model.

Figure 1 shows a comparison of real data with simulated Poisson model and Figure 2 shows a comparison of real data with simulated Gaussian model.

The next step is to compare the averages that of empirical data with the average of simulated data to see if the data simulated can be used to represent the real process in a correct way. There are many tests to compare the averages for the two populations, but we will use T test for the difference between the averages of the two populations (unknown and unequal variances) (Kanji, 2006). T test values (Table 1, 2, 3) and graphs indicate that Gaussian model best fits our data.

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Table 1: Paired samples statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**r**	5.1250	24	2,07076	0,42269
	N	5.15	24	1,79989	0,3674
Pair 2	**r**	5.1250	24	2,07076	0,42269
	P	4.17	24	2,99244	0,61083

Source: Author

Table 2: Paired samples correlations

	N	Correlation	Sig.
Pair 1 r&N	24	-0.184	-0.391
Pair 2 r& P	24	-0.229	-0.282

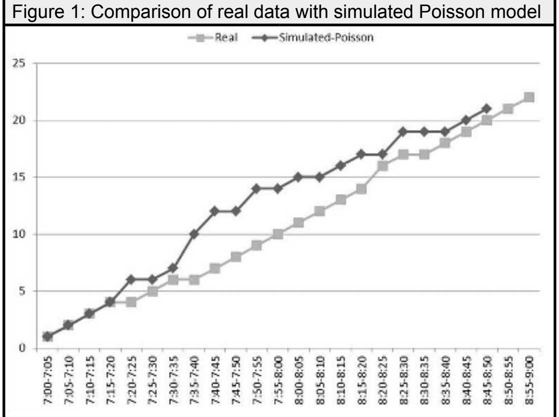
Source: Author

Table 3: Paired samples test

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig.(2-tailed)
				Lower	Upper			
Pair 1 r-N	**-0.31647**	2.98255	0.60881	-1.57589	-0.94295	-0.520	23	0.608
Pair 2 r-P	**-0.58333**	4.00995	0.81853	-1.10992	2.27659	0.713	23	0.483

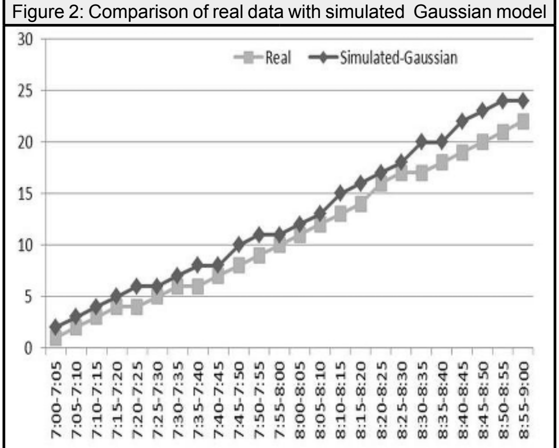
Source: Author

Figure 1: Comparison of real data with simulated Poisson model



Source: Author

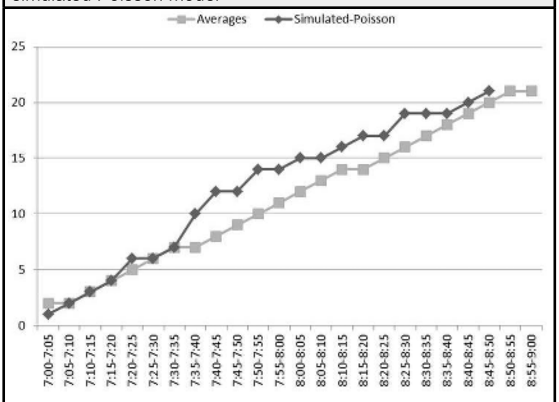
Figure 2: Comparison of real data with simulated Gaussian model



Source: Author

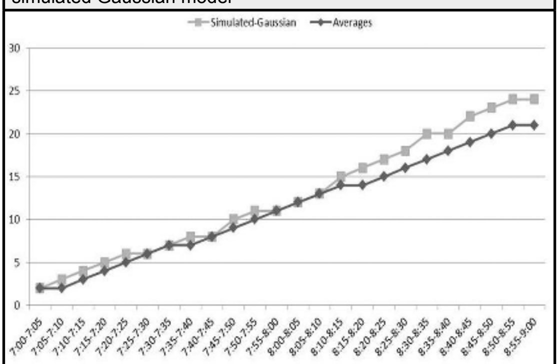
Figure 3 shows a comparison of the averages between real data and simulated Poisson model. Figure 4 shows a comparison shows a comparison of the averages between real data and simulated Gaussian model.

Figure 3: Comparison of the averages between real data and simulated Poisson model



Source: Author

Figure 4: Comparison of the averages between real data and simulated Gaussian model



Source: Author

Conclusion

Finding an appropriate model to describe bus headways is a very important step towards public transport improvement and efficiency maximization to assist citizens.

In our study were compared two important models: Poisson and Gaussian. For both these models were performed data simulation taking as simulation time interval of 2 hours to match real time of observation in field and to give as much credibility as possible to simulated model comparing to that real.

To compare the two models graphical and statistical tests were used. It was concluded that both models have appropriate significance for usage in modeling.

Although in different situations each of them can have advantages in our case Gaussian model resulted more suitable for modeling the headway times.

The findings of the study are generalized. Our goal is to create a methodology so it will be chance for more detailed studies using data measured with greater precision and during a longer interval of time.

REFERENCES

Millar B.R., Maximum Likelihood Estimation and Inference, with examples in R, SAS, and ADMB. John Wiley and Sons, 2011.

Akchelik E., Chung R., Calibration of the bunched exponential distribution of arrival headways. Road and Transport Research, N:3, 42-59, 1994.

Kanji, G. K. 100 statistical tests. SAGE Publications, 2006.

Law M.A, Kelton D.W. Simulation Modeling and Analysis. McGraw-Hill Companies Inc, 2000.

Leka, S. Teoria e propabiliteteve dhe statistika matematike. Tirana: SHBLU,ISBN : 99927-0-224-9 , 2004.

Raço, E. A combination of statistical methods with GIS in modeling. International Conference: Information Systems and Technology Innovation: their application in Economy (p. 58). Tirana: ISBN:978-9995-6377-8-1, 2012.

Raghu, P. Generating homogenous Poisson Processes. Wiley Encyclopedia of Operations Research and Management Science, 2, 2011.