

# TIMON Project: Description and Preliminary Tests for Traffic Prediction Using Evolutionary Techniques

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## ABSTRACT

TIMON is an EU research project under the programme Horizon 2020 that aims at creating a cooperative ecosystem integrating traffic information, transport management, ubiquitous data and system self-management. The objective of TIMON is to provide real-time services through a web based platform and a mobile APP for drivers, Vulnerable Road Users (VRUs) and businesses. These services will contribute to increasing drivers and VRUs assistance. In this project, many of the services mentioned before are supported by a traffic state prediction system. For this reason, the objective of this study is to lay the groundwork for developing an efficient prediction tool. In this work, a preliminary study is shown, comparing the performance of three different evolutionary methods.

## Keywords

TIMON; Traffic Prediction; GACE; Route Planning; Traveling Salesman Problem

## 1. INTRODUCTION

TIMON is an european project supported by the European Union's Horizon 2020 research and innovation programme<sup>1</sup>. The main objectives of this project are to increase the safety, sustainability, flexibility and efficiency of road transport systems by taking advantage of cooperative communication and by processing open data related to traffic. To this end, a cooperative open web based platform and a mobile application will be developed with the purpose

<sup>1</sup><http://www.timon-project.eu/>

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of delivering information and services of drivers, businesses and Vulnerable Road Users in real time.

TIMON counts with a wide group of partners, and an external panel of experts, composed by City Councils, vehicles suppliers, road transport experts, etc. In line with this, DeustoTech Mobility<sup>2</sup> is the partner in charge of developing the package related to the route planning and traffic forecasting.

In this work, some preliminary experiments on traffic prediction are shown. These tests have been performed with the intention of establishing a basis for the further development of the traffic prediction system. For this purpose, an experimentation has been conducted with three evolutionary techniques, in order to decide which test provides better results. These techniques have been chosen because of their proven efficiency in this task and their evolutionary nature.

The rest of this paper is structured as follows: in the following section, the role of the traffic forecasting in TIMON is described. Then, the experimentation carried out to test the evolutionary techniques used for the prediction is detailed. Finally, the conclusions of this preliminary study are pointed in Section 4

## 2. TRAFFIC PREDICTION IN TIMON

In TIMON, traffic forecasting is used in some contexts. The main application of the traffic prediction is given in the service called *Enhanced Real Time Traffic Information API*. This service aims to provide information related to the density of traffic in areas of interest, and highly accurate predictions on traffic congestion based on cooperative Intelligent Transport Systems (ITS), infrastructure sensors and open data. This service is also intended for business-oriented applications, such as fleet management companies (logistic companies, postal services etc.), requiring for a reliable estimation of the time delay on the selected route.

The API will provide different relevant data on traffic on selected areas, such as: congestion predictions, road accidents, roadworks, traffic density areas, level of heavy duty vehicle areas, etc.

<sup>2</sup><http://mobility.deustotech.eu/>

Besides this service, traffic forecasting is also used in all the services related to the dynamic-route planning. In these cases, a traffic prediction is performed before the running of the route planning method. The outcomes of these predictions are used to feed the planning techniques, in order to provide good quality routes to the users.

For this reason, an accurate traffic prediction system is an important element within TIMON's structure.

### 3. EXPERIMENTATION

As has been mentioned, three different methods have been compared in this preliminary experimentation. These methods have been picked because of their efficiency and their evolutionary nature.

The first used method is called GACE [2], and it combines a Genetic Algorithm (GA) with a Cross Entropy method (CE). This method works with two sub-populations. The method is created to improve the different parts of a Hierarchical Fuzzy Rule Based System. This hierarchy is used for congestion forecasting.

The remaining used techniques are the Linear Decreasing Weight-Particle Swarm Optimization (LDWPSO) [4], and Steady-State Genetic Algorithm for Extracting Fuzzy Classification Rules (SGERD) [3].

The MATLAB Software has been used for the development and execution of GACE algorithm. On the other hand, KEEL<sup>3</sup> framework has been used for the run of LDWPSO and SGERD, using the default parametrization for each technique. In addition, three different configurations have been used for the GACE. Each of these configurations have been called as  $GACE_{x-y}$ , where  $x$  is the size of the GA subpopulation, and  $y$  the size of the CE subpopulation

The data used in this work was provided by the Caltrans Performance Measurement System<sup>4</sup>. A 9-km-long section of highway I5 in Sacramento, California, is used for this research. Briefly explained, PD and SPD datasets aim at predicting the congestion at a single point, while SD and SSD aim at predicting it in the whole road section. On the other hand, PD and SD use all the available information while SPD and SSD use a reduced number of features of the dataset. In addition, three different time horizons have been used: 5, 15, and 30 minutes. Each dataset has its time horizon in its subindex. For further details about the datasets, the interested reader is referred to [2].

The results obtained by all the methods are shown in Table 1. In this table, the results are depicted as the average symmetric mean absolute percentage error (sMAPE) [1] in the test datasets.

Analyzing the results shown in Table 1, it can be concluded that GACE is the most appropriate technique for these datasets. GACE obtains better results than LDWPSO and SGERD in 11 out of 12 datasets. More concretely, the variation  $GACE_{45-5}$  is the one which has demonstrated a better performance.

In overall, it can be concluded that the utilization of GACE, either with  $GACE_{45-5}$  or  $GACE_{40-10}$  configuration, can be an appropriate choice for the prediction system of TIMON project. Besides that, two different statistical tests have been conducted with the results obtained in order to obtain rigorous and fair conclusions. These tests are

**Table 1: Comparison of GACE techniques with LDWPSO, and SGERD algorithms[2]**

Dataset	$GACE_{45-5}$	$GACE_{40-10}$	$GACE_{35-15}$	LDWPSO	SGERD
$PD_5$	0.022	<b>0.020</b>	<b>0.020</b>	0.100	0.043
$PD_{15}$	<b>0.011</b>	<b>0.011</b>	0.013	0.100	0.043
$PD_{30}$	0.017	<b>0.016</b>	0.017	0.089	0.043
$SPD_5$	0.019	0.018	0.025	<b>0.013</b>	0.604
$SPD_{15}$	0.016	<b>0.011</b>	0.012	0.027	0.108
$SPD_{30}$	0.027	<b>0.021</b>	<b>0.021</b>	0.027	0.029
$SD_5$	<b>0.199</b>	0.202	0.204	0.606	0.202
$SD_{15}$	0.240	0.251	<b>0.217</b>	0.604	0.396
$SD_{30}$	<b>0.186</b>	0.244	0.210	0.602	0.395
$SSD_5$	<b>0.201</b>	0.234	0.296	0.362	0.684
$SSD_{15}$	<b>0.256</b>	0.322	0.344	0.423	0.766
$SSD_{30}$	<b>0.221</b>	0.328	0.299	0.310	0.270

the Friedman's non-parametric test, and the Holm's post-hoc test. Thanks to this statistical experimentation, it has been proven how GACE obtain significant results comparing with LDWPSO and SGERD. Additionally,  $GACE_{45-5}$  has been confirmed as the best alternative, despite obtaining not significant results comparing with  $GACE_{40-10}$  and  $GACE_{35-15}$ .

### 4. CONCLUSIONS

In this short paper, TIMON project has been described, along with some experiments related to the traffic forecasting. This experimentation has been performed with the intention of testing three different techniques for traffic state prediction. As has been mentioned, the traffic forecasting is an important element within TIMON project. The conducted tests have shown that GACE offers better precision in the predictions.

As future work, similar studies related to the route planning have been planned. A preliminary approach can be the comparison of different techniques for the resolution of routing problems, such as the Traveling Salesman Problem or the Shortest Path Problem.

### 5. ACKNOWLEDGMENTS

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<sup>3</sup><http://www.keel.es/>

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