Algorithmic Method for the Traffic Lights Regulation Project in the city of Shkodra

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The largest artery of the Albanian Road Network, the North-South Corridor, comprising most of its main interurban roads, crosses the territory of the Region.

Demographic changes also conditioned the need to design new transport systems to cope with an increased flow of vehicles.

We think that this paper contributes to this goal, which theoretically addresses the problems of improving the traffic lightening of the city of Shkodra, combined with the use of Intelligent Transport Systems

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On this occasion, the algorithms proposed by the literature for the joint project of topology and traffic lights regulation were tested, with the aim of achieving three objectives:

- Calibration of control parameters used in topology project phase approximations;
- Analysis of the characteristics obtained from different approximations;
- Comparison of topology indicators and configurations dealing with proposed "what to" methods with those of "what if" methods used in practice.

Method with Hill Climbing Algorithm (HC)

This algorithm needs no calibration as it is not controlled by any parameters.

The values of the processing results are given in Table. 815 topological configurations were processed before the minimum was found (however smaller than the 2x104 limit attempt).

The City	Elaborate configurations	The best value, w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	815	1456,4	8,41 %	1590,2 [h]

Method with Simulated Annealing (SA) Algorithm

The controlling parameters are:

- Initial temperature τo ;
- Final temperature τp.

The field step length is accepted **λp =100** and cooling rate **αc** is taken as a function of the initial and final temperatures.

Given the recommendations in the literature for similar cases, they are accepted **τo≅ wo** and **τp≅10-4 wo.**

The City	τ_0 [h]	τ_p [h]	α_c	λ_p	The best value,w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	1000 100 10 1	100 10 1 0,1	0,989	100	1564,3 1556,2 1524,7 1535,9	1,63% 2,14% 4,12% 3,41%	1590,2 [h]

Method with Tabu Search Algorithm (TS)

There is only one parameter that controls the specificity proposed by TS: tabu list dimension **λl**.

The results of the processing with the change of the calibrated parameter are given in Table 4.

The City	λ_l	The best value, w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	0	1521,66	4,31%	1590,2 [h]
	5	1505,60	5,32%	
	10	1495,42	5,96%	
	20	1489,22	6,35%	
	30	1493,03	6,11%	
	35	1519,27	4,46%	
	40	1518,64	4,50%	
	50	1521,50	4,32%	
	55	1515,77	4,68%	
	60	1522,67	4,24%	
	70	1516,09	4,66%	

Method with Genetic Algorithms (GA)

There are four parameters that control the specificity of Genetic Algorithms:

- entirety coefficient of population, νp;
- selectivity parameter, αr;
- crossover frequency, φc;
- frequency of change, φn.

In the literature [1], a set of calibrated parameters is given (νp = 40, αr = 70, φc = 0,40, φn = 0,20). The calibration results are given in Table 5.

Method with Genetic Algorithms (GA)

The City	ν_p	α_r	φ_c	φ_n	The best value, w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	40	70	0,40	0,20	1536,92	3,35%	1590,2 [h]
	20	70	0,40	0,20	1528,34	3,89%	
	80	70	0,40	0,20	1524,20	4.15%	
	40	30	0,40	0,20	1531,99	3,66%	
	40	140	0,40	0,20	1535,33	3,45%	
	40	70	0,20	0,20	1549,17	2,58%	
	40	70	0,80	0,20	1437,24	9,62%	
	40	70	0,40	0,10	1491,44	6,21%	
	40	70	0,40	0,40	1540,58	3,12%	

Hybrid Method 1 (TS + GA)

The parameters that control the specificity of the hybrid method are six:

- Tabu Search parameter - λl.
- Parameters of Genetic Algorithms - νp; αr; φc; φn.
- The parameter that determines the part of the solutions considered with TS, denoted by τ_%.

Being too many parameters to be calibrated, the best values obtained from the calibrations by particular methods are accepted. Part of the solutions considered with TS is accepted τ_% = 75% and the one with GA: 1- τ_% = 25%.

The City	Hybrid Method 1	The best value, w^* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	TS→GA GA→TS	1489,22 1437,24	6,35 9,62	1590,2 [h]

Hybrid Method 2 (TS + PR)

The only parameter that controls the specificity of this hybrid method is the tabu list dimension λl.

From the literature recommendations, it is best to obtain a value that is close to the values of the parts of the project. The processing results are given in Table 7.

The City	λ_l	The best value, w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	0	1510,21	5,03	1590,2 [h]
	5	1500,51	5,64	
	10	1494,94	5,99	
	20	1492,56	6,14	
	30	1490,49	6,27	
	35	1510,05	5,04	
	40	1481,27	6,85	
	50	1511,96	4,92	
	55	1502,26	5,53	
	60	1509,25	5,09	
	70	1503,37	5,46	

Double Round Hill Climbing Method (HC2)

This method is not adjusted by any parameters and therefore does not need to be calibrated.

Table 8 gives the results after processing 3145 topological configurations before the local minimum was found, (even in this case, less than the recommended $2 \cdot 10^4$ limit).

The City	Processing configurations	The best value, w* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	3145	1475,70	7,20 %	1590,2 [h]

In conclusion, let's look at the analysis of the comparison of the results obtained with each of the methods. To this end, Table 9 gives the best recorded values

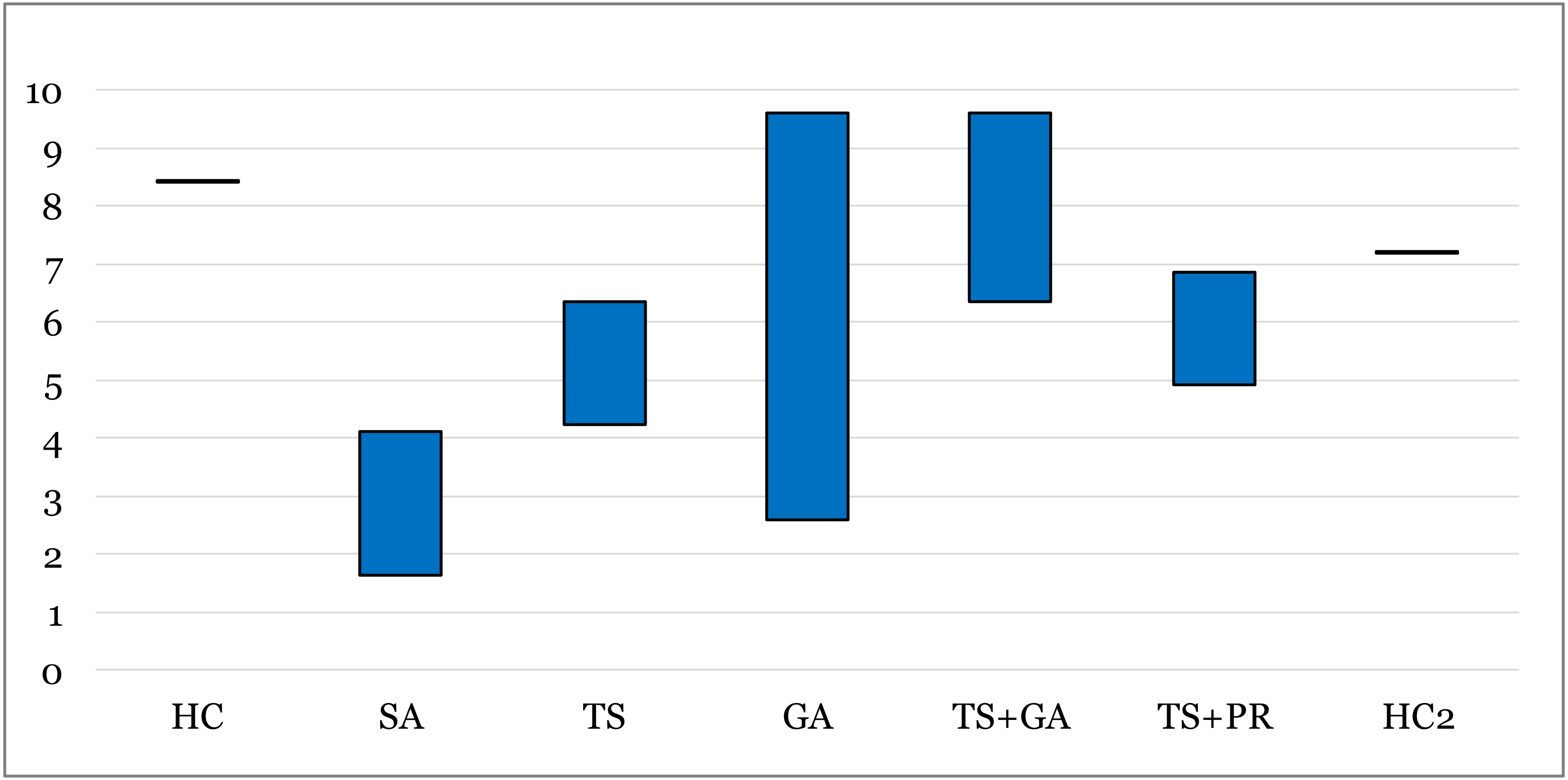
The City	Algoritmi	The best value, w^* [h]	Decrease $\Delta w^{\%}$	Initial value w_0 [h]
Shkodër	HC	1456,4	8,41 %	1590,2 [h]
	SA	1524,7	4,12%	
	TS	1489,22	6,35%	
	GA	1437,24	9,62%	
	TS+GA	1489,22	6,35%	
	TS+PR	1481,27	6,85%	
	HC2	1475,70	7,20 %	

3. CONCLUSIONS

Given the different number of applications for different methods, and because different sets of parameters were used for each method, the results obtained should be considered preliminary.

It results that the percentage reduction of the objective function is included in the range (4.12% -9.62%), which is considered wide [4] and indicates the need to use the best algorithms with the optimal parameters. The reduction intervals of the objective function, for each method and with the change of the parameters used, are given in Fig. 2.

3. CONCLUSIONS



3. CONCLUSIONS

Interpreting the graph, the best algorithm comes out Hybrid Method 1 (TS + GA).

The purpose of this paper is to analyze the algorithms used to calibrate the parameters for the project phase of the traffic light regulation project.

To make a comparison as close to reality as possible, the same transport system can be used, but it is recommended to study a city with approximate parameters.

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THANK YOU!