DETERMINING AN OPTIMAL ROUTE FOR VISITATION OF TOURIST OBJECTIVES IN TIMIŞ COUNTY

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RESEARCH ARTICLE

Abstract

The list of tourist attractions in Timiş County is constantly changing. The existence of new routes, the time required to travel the distances between the attractions, make the optimal route to travel the attractions change over time. The paper proposes a list of attractions considered important to be viewed and presents a way of working to determine an optimal route to be achieved using the estimated time by a vehicle navigation application. Certain opinions are also expressed regarding the application of the Traveling Salesman Problem in the field of tourism.

Keywords: Tourist routes, Timiş County, Romania, Traveling Salesman Problem
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INTRODUCTION

The optimal passage of certain points is a classic concern in the field of operational research. Graph theory indicates algorithms used for this purpose. Their use has long been a scientific concern with the aim of reducing travel expenses or time spent, most often in the military, industrial, economic or other fields and very rarely in private fields. The relatively complicated calculations have meant that these studies have long been bypassed by tourists, either in private or through travel agencies proposing tourist itineraries. Currently, however, solutions are emerging that simplify the approach to this topic, thanks to predefined software modules (Koh K., 2023; Panneerselvam R., 2023).

The Traveling Salesman Problem is the mathematical model used in this paper. Specifically, given a list of locations for which the distance between them is known (or the travel time for the distances), the goal is to find a route with a minimum length such that each location is visited once. (SAS documentation 2025; Matai, 2010; Gutin 2006).

The purpose of the paper is to specifically analyze a tourist route based on important objectives in Timiş County and to determine an optimal route for their travel. Another purpose is to update at a didactic approach the list of mathematical models and solutions for solving their applications within the programs of applied mathematics disciplines in the field of tourism.

Timişoara is located close to the center of Timiş County. The distance to the furthest point of the county is slightly more than 100 km. The European Road network is of good quality. The A_1 motorway runs through Timiş County from the border with Arad County to the border with Hunedoara County, over a section of approximately 96 km. This helps to quickly transit the county. The networks of communal or agricultural roads, even in the mountainous area of the county, roads developed in recent times, bring new possibilities for approaching tourist routes between different localities.

MATERIAL AND METHOD

Travel time between locations was determined using the Google Maps application. (Google Maps, 2025). In order to solve the Graph Theory problem, more precisely determining the optimal path, SAS Studio -Network Optimization/ Traveling Salesman Problem – Optnet Procedure, version 3.8, was used.

The localities and tourist attractions proposed as points on the route are shown in table 1.

Table 1

Proposed localities and tourist attractions

Localities	Tourist attractions
Băile Calacea	Geothermal pool
Pietroasa	Blue Cave
Tomeşti	Monastery Izvorul lui Miron
Gătaia	Monastery Săraca
Bucovăţ	Dendrological park Bazoş
Recaş	Recaş Winery
Herneacova	Herneacova Domain
Satchinez	Banat Delta - Satchinez swamps
Fârdea	Lake Surduc
Nădrag	Cornet Waterfall

RESULTS AND DISCUSSIONS

Băile Calacea is a locality in the commune of Orţişoara. It has a recreational area bordered by a centuries-old forest. Geothermal waters with a temperature of 38-39 C are used in the treatment base but also for relaxation purposes (Planiada, 2025).

Pietroasa commune is in the east of Timiş county, at the base of the Poiana Ruscă Mountains. The wooden churches on the territory of this locality and of the neighbouring localities, with an age of approximately 3 centuries, the traditional houses, the local producers, bring an authentic aspect to the area. The caves in the area, through the related tourist routes and the organized cultural events bring a significant number of tourists, in all periods of the year (Pietroasa City Hall, 2025). Nearby is the Tomeşti locality, in the vicinity of which we find recreational areas, accommodation spaces and restaurants but also agrotourism guesthouses. Important points of attraction are the monasteries in the area (Tomeşti Commune, 2025).

Gătaia is a town in the south of Timiş County. In the vicinity, near the village of Şemlacul Mic, you can visit the Săraca Monastery, which has an old church built in the 15th century (Moisescu C., 2001).

The Bazoş Dendrological Park was established in the early 1900s and is located in the territory of the Bucovăţ commune (Milea, 2012). It has a large number of plant species that are not specific to the area but are currently adapted.

A representative wine-growing area for western Romania is the city of Recaş. The Recaş wineries bring Romanian wine to a category of success at an international level (Mălăescu, 2014).

In the vicinity of the city, there is Herneacova, with an adventure park, riding fields and recreational areas that bring a large number of tourists.

The marshes in the vicinity of Satchinez, with various species of waterfowl, bring a different landscape than expected in this plain area, being comparable in some aspects, in terms of fauna and flora, to the Danube Delta (Ariton, 2017).

Lake Surduc in the commune of Fârdea brings tourists interested in water sports but also in the neighboring recreational areas (Sicoe-Murg, 2022).

The town of Nădrag, located in the mountainous area in eastern Timiş county, has a series of tourist routes that offer an attractive natural setting throughout the year (Mateoc N., 2023).

Solving a problem that involves determining such an optimal route, which includes all localities, through an undirected search can be done with a very large number of variants. For n localities, this results in (n-1)! variants (Universal Teacher Publications, 2007-2014).

This can lead to a very high number of variants when the number of localities is large. For example, if we have 11 localities, the number of route variants reaches (11-1)!=10! That is,

$$10x9x8x...x1=3628800$$

variants. This number is certainly impossible to verify.

Mathematically, the problem is to minimize the total cost of the route,

$$\min \sum_{i,j} c_{ij} x_{ij}$$

where c_{ij} represents the cost of traveling the distance between locations i and j (which can also be the duration of the trip) and x_{ij} represents a binary variable (Hoffman, 2013) which is described by the expression

$$x_{ij} = \begin{cases} 1, \text{if } i \to j \text{ is in the tour} \\ 0, \text{otherwise} \end{cases}.$$

Theoretically following the way, the mathematical model is described it is found that there are several variants of this problem. Regarding symmetry, there is a situation in which $c_{ij}=c_{ji}$, meaning the costs are equal in both directions. When we refer to the time travelled, the symmetry is not fulfilled. Traveling in one direction can be much different in time compared to traveling in the opposite direction, at certain times of the day.

Starting from the locations in table 1, the travel time was determined using Google Maps, with vehicle category. The results are shown in Table 2.

Table 2

Travel time (minutes) between localities with tourist attractions

Start	Destination	Travel time (minutes)	Start	Destination	Travel time (minutes)
Timişoara	Băile Calacea	31	Bucovăţ	Recaş	19
Timişoara	Pietroasa	75	Bucovăţ	Herneacova	25
Timişoara	Tomeşti	73	Bucovăţ	Satchinez	43
Timişoara	Gătaia	59	Bucovăţ	Fârdea	54
Timişoara	Bucovăţ	22	Bucovăţ	Nădrag	70
Timişoara	Recaş	32	Recaş	Timişoara	29
Timişoara	Herneacova	38	Recaş	Băile Calacea	39
Timişoara	Satchinez	41	Recaş	Pietroasa	56
Timişoara	Fârdea	67	Recaş	Tomeşti	53
Timişoara	Nădrag	82	Recaş	Gătaia	72
Băile Calacea	Timişoara	34	Recaş	Bucovăţ	15
Băile Calacea	Pietroasa	81	Recaş	Herneacova	10
Băile Calacea	Tomeşti	80	Recaş	Satchinez	45
Băile Calacea	Gătaia	84	Recaş	Fârdea	48
Băile Calacea	Bucovăţ	37	Recaş	Nădrag	62
Băile Calacea	Recaş	40	Herneacova	Timişoara	37
Băile Calacea	Herneacova	46	Herneacova	Băile Calacea	47
Băile Calacea	Satchinez	13	Herneacova	Pietroasa	63
Băile Calacea	Fârdea	72	Herneacova	Tomeşti	61
Băile Calacea	Nădrag	87	Herneacova	Gătaia	79
Pietroasa	Timişoara	77	Herneacova	Bucovăţ	25
Pietroasa	Băile Calacea	84	Herneacova	Recaş	9
Pietroasa	Tomeşti	13	Herneacova	Satchinez	54
Pietroasa	Gătaia	118	Herneacova	Fârdea	55
Pietroasa	Bucovăţ	63	Herneacova	Nădrag	69
Pietroasa	Recaş	55	Satchinez	Timişoara	37
Pietroasa	Herneacova	63	Satchinez	Băile Calacea	13
Pietroasa	Satchinez	88	Satchinez	Pietroasa	89
Pietroasa	Fârdea	42	Satchinez	Tomeşti	87
Pietroasa	Nădrag	57	Satchinez	Gătaia	87
Tomeşti	Timişoara	75	Satchinez	Bucovăţ	43
Tomeşti	Băile Calacea	81	Satchinez	Recaş	48
Tomeşti	Pietroasa	13	Satchinez	Herneacova	54
Tomeşti	Gătaia	116	Satchinez	Fârdea	80
Tomeşti	Bucovăţ	60	Satchinez	Nădrag	95

Tomeşti	Recaş	53	Fârdea	Timişoara	66
Tomeşti	Herneacova	61	Fârdea	Băile Calacea	75
Tomeşti	Satchinez	87	Fârdea	Pietroasa	41
Tomeşti	Fârdea	39	Fârdea	Tomeşti	39
Tomeşti	Nădrag	55	Fârdea	Gătaia	103
Gătaia	Timişoara	60	Fârdea	Bucovăţ	54
Gătaia	Băile Calacea	78	Fârdea	Recaş	48
Gătaia	Pietroasa	112	Fârdea	Herneacova	57
Gătaia	Tomeşti	110	Fârdea	Satchinez	80
Gătaia	Bucovăţ	57	Fârdea	Nădrag	19
Gătaia	Recaş	67	Nădrag	Timişoara	80
Gătaia	Herneacova	75	Nădrag	Băile Calacea	89
Gătaia	Satchinez	88	Nădrag	Pietroasa	56
Gătaia	Fârdea	100	Nădrag	Tomeşti	54
Gătaia	Nădrag	95	Nădrag	Gătaia	102
Bucovăţ	Timişoara	22	Nădrag	Bucovăţ	69
Bucovăţ	Băile Calacea	32	Nădrag	Recaş	62
Bucovăţ	Pietroasa	62	Nădrag	Herneacova	71
Bucovăţ	Tomeşti	60	Nădrag	Satchinez	95
Bucovăţ	Gătaia	57	Nădrag	Fârdea	19

Source: Own calculations using Google Maps

These data were used to determine the optimal route as a travel time, which would allow visiting all these points.

Since the travel time between the locations was determined as the fastest option generated by the Google Maps application, there is a possibility that sometimes the route is not the most suitable option from a tourist point of view. These situations can be established concretely, choosing the most convenient route between the locations.

The order of travel of the points is presented in table 3. The results are those obtained after solving the Traveling Salesman Problem using SAS Studio.

Table 3

The optimal route and total travel time between localities with tourist attractions

Edge	Start	Destination	Travel time (minutes)
1	Timişoara	Băile Calacea	31
2	Băile Calacea	Satchinez	13
3	Satchinez	Bucovăţ	43
4	Bucovăţ	Herneacova	25
5	Herneacova	Recaş	10
6	Recaş	Pietroasa	55
7	Pietroasa	Tomeşti	13
8	Tomeşti	Fârdea	39
9	Fârdea	Nădrag	19
10	Nădrag	Gătaia	95
11	Gătaia	Timişoara	59
Total travel time			**402 minutes**

Source: Own calculations using SAS Studio

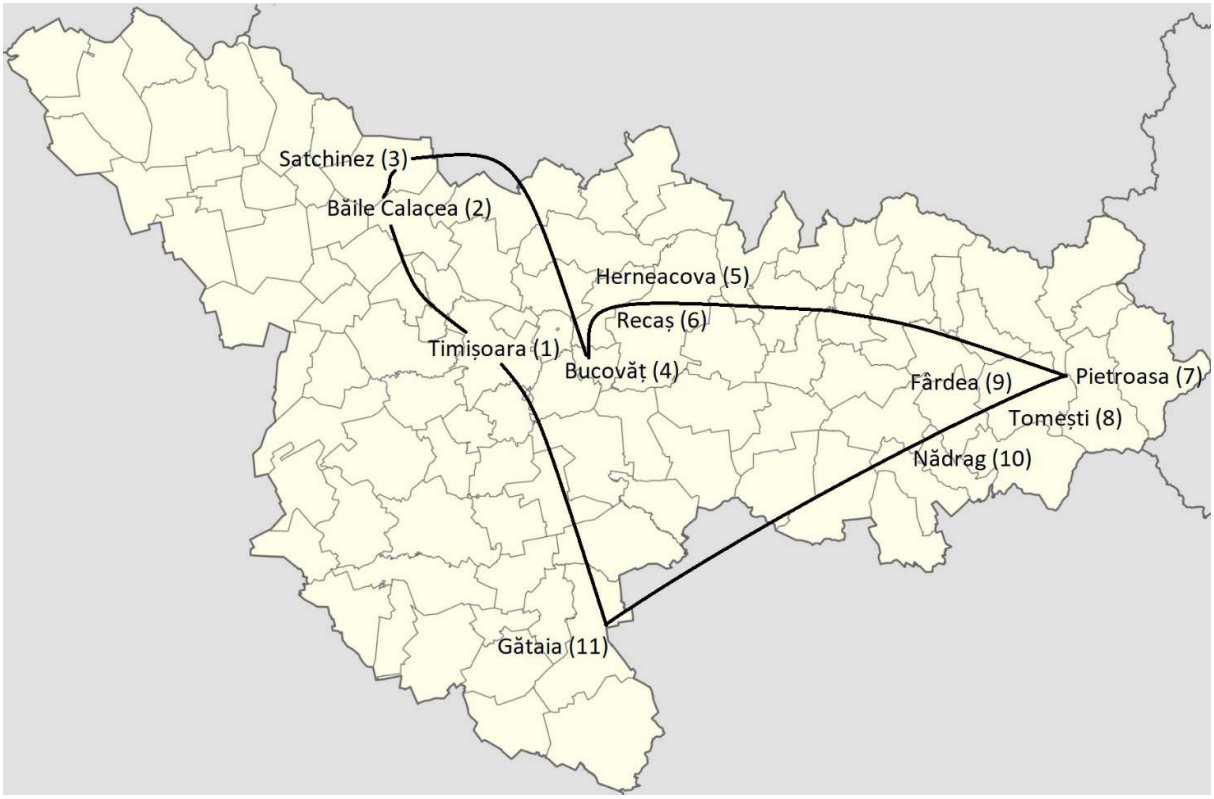
A presentation of the travel routes and their order is shown on the map of Timiș County, in Figure 1.

The time spent at the tourist attractions can be reported to the total travel time. In this case, it is 402 minutes. This will obtain a maximum of this ratio.

The data can be divided into several subgroups, and for each one an optimal route can be established. This approach can be carried out when the route is divided over several days.

Since the travel time between two localities is different at different times of the day, it is necessary to determine these values depending on the time of day. Congested or light traffic at certain times of the day is often periodic and allows good approximations.

Approximating travel time using Google Maps can also be done for other forms of travel, not just for cars. It can be done for hiking, cycling etc. This will allow for different routes from the general one. These can relate to the initial route.



Source: Own representation using NACLR map format (NACLR, 2025)

Figure 1 **The optimal route between localities with tourist attractions in Timiș County**

CONCLUSIONS

The large number of variants through which these trips can be made can be reduced using algorithms from graph theory. The benefits are immediate and can be related to saving time, optimizing travel costs but also to increasing the number of objectives that can be viewed in a fixed time.

In an indirect way, planning optimal routes brings a development of tourist activity, by increasing the number of people at a certain destination point. The time spent at tourist attractions compared to the time spent in the vehicle increases. The benefits on the local economy can be obvious.

The working method can be extended to other tourist areas but also for much larger routes.

Regarding the didactic aspect, the presentation of software packages that can solve problems of this type brings important benefits in improving the working and planning of experts in the field of tourism.

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