reviewed paper

Hiking Trip Selection Based On Reachability By Public Transport

Stefan Wagner, Gerhard Navratil, Hans Fiby

(Dipl.-Ing. Stefan Wagner, ITS Vienna Region, stefan.wagner@its-viennaregion.at)
(PD Dipl.-Ing. Dr. Gerhard Navratil, TU Wien, Department for Geodesy and Geoinformation, navratil@geoinfo.tuwien.ac.at)
(Dipl.-Ing. Hans Fiby, ITS Vienna Region, hans.fiby@its-viennaregion.at)

1 ABSTRACT

Smart cities should enable the citizens to utilize available ressources. One of the goals is the reduction of individual motorized traffic. However, many citizens still use cars to get to the location of an ourtdoor activity. As a concrete example we use hiking trips and identify those that can be reached by public transport. The result is a map (and a corresponding GIS data set) showing the hiking locations for a single day hiking trip. The concept can be used for various other applications although there are still open questions, e.g., what part of the answer can be precomputed and what should be determined on demand.

2 INTRODUCTION

Garau, Mundula, and Salustri define smart cities as systems of knowledge (Garau et al, 2014). However, this is only one vision. Smart cities should also be climate neutral (Montlleó et al, 2014), livable, innovative, and sustainable (Wendt et al., 2014). A brief overview on aspects and ideas has been presented by Bajracharya et al. (2014). One of the general goals, though, is the efficient use of available ressources. This is obviously space, energy, creativity, and money, but the existing infrastructure also belongs to these ressources. Public transportation of any form is part of this infrastructure and if it is used efficiently several goals are addressed simultaneously because motorized individual traffic is reduced. This requires less fossile fuel, produces less emmissions including noise, and requires less space. However, we need better tools to avoid extensive trip durations and make public transportation alternatives more visible. In this paper we show a reachability analysis for hiking paths around Vienna.

There are several databases on hiking paths in Austria and schedule data for public transport is available in digital form, too. A problem for an interested user is the combination of these sources. Selecting a hiking path from a webpage and use a car to get there is simple. Checking the possibility to use public transportation to get to the hiking path may be frustrating, though since some destinations are not reachable or the trips to the hiking track simply take too long. A user-centreed approach could consist of the following steps:

(1) User preferences are collected (start location, maximum duration of the whole trip, hiking length, difficulty level, etc.)

(2) Possible choices are determined and presented on a map

(3) The user selects a destination and receives all necessary information for the trip (required tickets, departure times, etc.)

A similar analysis has been performed by Neis et al. (2007). They illustrated a web based reachability analysis in order to assess the housing market in Rheinland Pfalz in Germany. They describe the architecture of the analysis, the calculation, request and response parameters as well as the prototype of the frontend. In the outlook Neis et al. refer to further potential uses of web based GIS analysis such as disaster management or individual tour suggestions for tourists, an idea pursued further in this paper. The focus is on the determination of possibilities. The reachability analysis should be able to obey sets of data: the schedule data which is in fact the travel time of the public transport system and the information on hiking trips, e.g., the duration. The results of the reachability analysis is displayed on a map and could then be offered as a web service.

The structure of the paper follows the workflow of such a project. We start with the description of available data and services. Then we present the design decisions used to simplify the concept. In section 5 we focus on the implementation and briefly discuss error handling. Results are shown in section 6 and their discussion concludes the paper.

3 AVAILABLE DATA AND SERVICES

Analysis requires data and—if the data is accessible on the Internet—methods to access the data. In this section the data and services used for the project are described.

3.1 Hiking Data

Data on hiking routes in Austria were provided by Outdooractive, a platform for outdoor activities such as hiking. In order to get data of high quality, the company cooperates with tourism institutions and Alpine clubs. According to the information of the Outdooractive website , the platform provides around 95,000 outdoor activity tours (hiking, cycling, and other outdoor adventures) and corresponding official maps. The service provides an API to access the content as UTF-8 XML documents . In order to get access to the data a valid API key as well as a valid project key is necessary.

Data on tours or points of interest (POIs) can be requested. Geographical selection is possible based on hierarchical regions:

- Political: continent, country, province, district, community
- Tourism: tourism area, custom area
- Nature: mountain area, protected area

Each political area is split into tourism regions and each tourism region may contain information on the nature type.

Tour element contains a number of interesting elements:

- text elements,
- tour geometry,
- numbers,
- related POIs,
- elevation profile,
- and exposition.

Several of these elements are necessary for the reachability service. Each destination must be labeled for the user and the title of the hiking tour is stored in the description. Further important elements include the starting point description, safety guidelines or required equipment. The tour geometry itself is stored as a line string of geographical 2D coordinates based on WGS84 following the OGC (Open Geospatial Consortium) specifications. Finally, information like duration, length, elevation, rating, difficulty, and season is also available. Difficulty, for example is assessed in three classes fom easy to difficult.

3.2 Public Transportation Data

ITS Vienna Region provides the routing platform “AnachB”. It is a traffic service for Austria with a special focus on the federal provinces of Vienna, Lower Austria and Burgenland. The route planner allows to determine the fastest route between two locations using individual or public transport. ITS Vienna Regions emerged from a cooperative telematics project founded by the three federal provinces of Vienna, Lower Austria and Burgenland and embedded in the public transport association Verkehrsverbund Ost-Region (VOR) in 2006. Therefore, the data used by AnachB is the same data used by the various branches of public transportation in the region and the data described the schedule up to date, completely, and correctly.

3.3 Routing Service

The routing service itself is already available at ITS Vienna Region. It is part of the route planer platform “AnachB”. The routing algorithm for public transport was developed by HaCon, a company specialized on high-quality software solutions for traffic, transport and logistics. The timetable information system is called HAFAS. HAFAS contains an external XML-Interface, which enables a client to query HAFAS. The routing request is transmitted to the server in XML format via the POST method of the HTTP protocol. The server processes the request and answers with a response in XML format.

The server can handle three different requests. A location validation request checks an address and returns the closest matches together with the geographical coordinates of the location. A connection request asks for public transport connections between two points. A station board request provides schedule information for a specific station. Finally, an intermodal routing request asks for a connection using individual transport modes such as a car or bicycle or public transport.

4 DESIGN DECISIONS

In order to keep the first prototype simple, several design decisions were made:

- Hiking trips should be finished within a single day including the trips to and from the hiking area. The target group are people looking for a hiking trip on a specific day.
- The results are precomputed. Each test if a hiking location fulfills above criterion requires several requests (at least two connection requests). In the eastern part of Austria 1,353 hiking paths are registered. Thus, if the result is created from scratch for each user, more than 3,000 requests would be necessary.
- Reasonable starting locations were selected to allow precomputation. Users starting in Vienna are assumed to start from a major railway station, Westbahnhof or Hauptbahnhof. Major train stations were used for Lower Austria and Burgenland.
- Different schedules on workdays, Saturday, Sundays, and public holydays are included. However, school holidays were ignored because they vary between the federal provinces. Schools are closed, for example, on November 11 in Burgenland and on November 15 in Vienna and Lower Austria due to the different patron saint.
- Duration of daylight is ignored, i.e., it may happen that a proposed trip requires walking in dark conditions.
- Public transportation is restricted to rail, tram, and bus lines. Although, theroretically airplanes would also count as public transportation, flying to Nicosia for a 2 hours hiking trip is neither economically justifyable nor ecologically sound.

Fig. 1 illustrates the idea of a single day trip. The user starts the trip and returns on the same day. Since hiking paths do not need to be circular, the start and end point of the hike may vary. This is an added benefit when using public transportation.

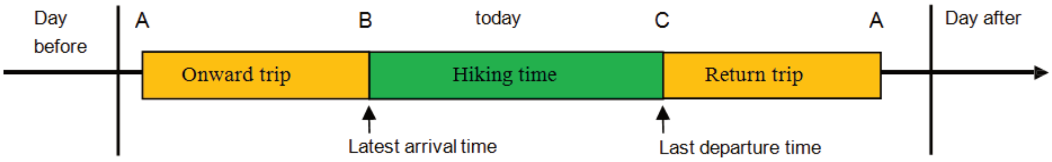

Fig. 1: Travel times and hiking time within one day (Wagner, 2015, p. 12).

5 IMPLEMENTATION

Figure 2 shows the concept of the reachability analysis. The blue elements represent data in XML-format. It is either data from HAFAS on public transportation schedules or data from the Outdooractive API on hiking paths. The violet elements indicate the two connection requests. The first connection request is sent to the server for getting the latest possible public transport connection on a specified day from the endpoint of the hiking path to the starting location. It does not matter if the first or the last connection is requested first. Depending on that, either the time calculation is processed in forward or backward direction. The description here used the backwards computation. The second request asks for the latest possible connection to reach the hiking destination early enough to go hiking and still have a public transport connection back home. The green elements indicate calculations. The time calculation computes the necessary arrival time for the second connection request by subtracting the hiking time from the departure time of the return trip. The second calculation decides if the trip takes less than a day and returns True or False. The grey arrows between the violet and blue elements represent server-client communication and show where the corresponding information is used.

ISBN 978-3-9504173-0-2 (CD), 978-3-9504173-1-9 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER

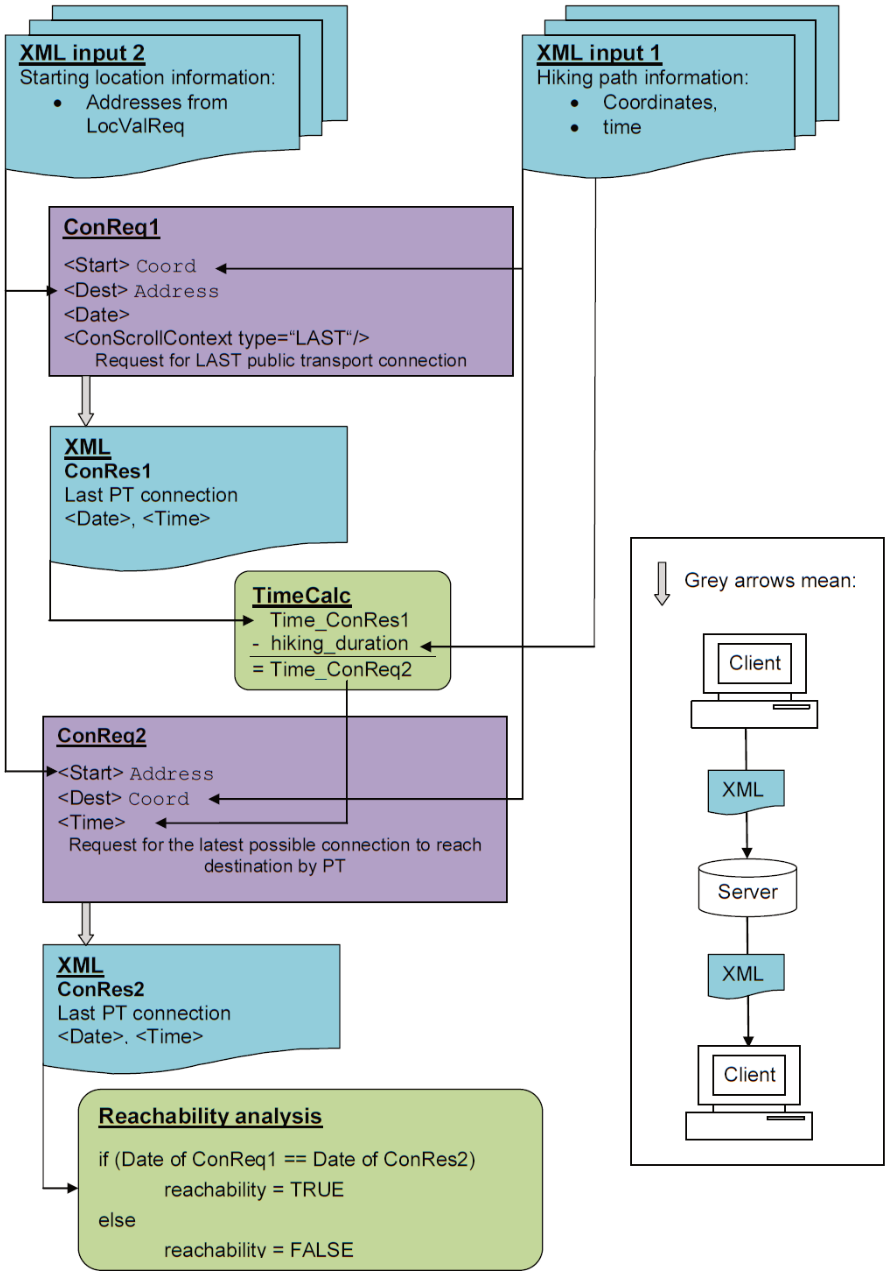

Fig. 2: Concept of the reachability calculation (Wagner, 2015, p. 40).

Errors may occur in two different locations of the flowchart. The first connection request may reveal that there is no public transport connection to the specified start of a hiking trip. The same may also happen during the second connection request for the start point of the return trip (the end of the hiking path). The errors may have two reasons. Either there is no public transportation station nearby the given coordinate or no connection in general could be found at all. The second case is rare and would reveal unconnected subnetworks of the public transportation system. The first case, however, results from that fact that hiking trips will rarely start or end precisely at public transportation stations. The start or end is specified by a set of coordinates and the server needs to identify the closest public transportation station. The server automatically sets a request to an individual transport router, which identifies the closest public transportation station and computes a walking route. The error occurs if no suitable station is found.

6 RESULTS

Fig. 3 provides a geographical overview. The names in the map indicate the starting locations. The territory of the Czech Republic, Slovakia, and Hungary is not represented because public transportation routing is restricted to Austrian territory and thus adding additional territories could be confusing. Of course, in times of international cooperations and open boundaries, a service like the one discussed in this paper should not stop at national boundaries. However, this is an issue of service availability and data reliability and can only be solved by international cooperation.

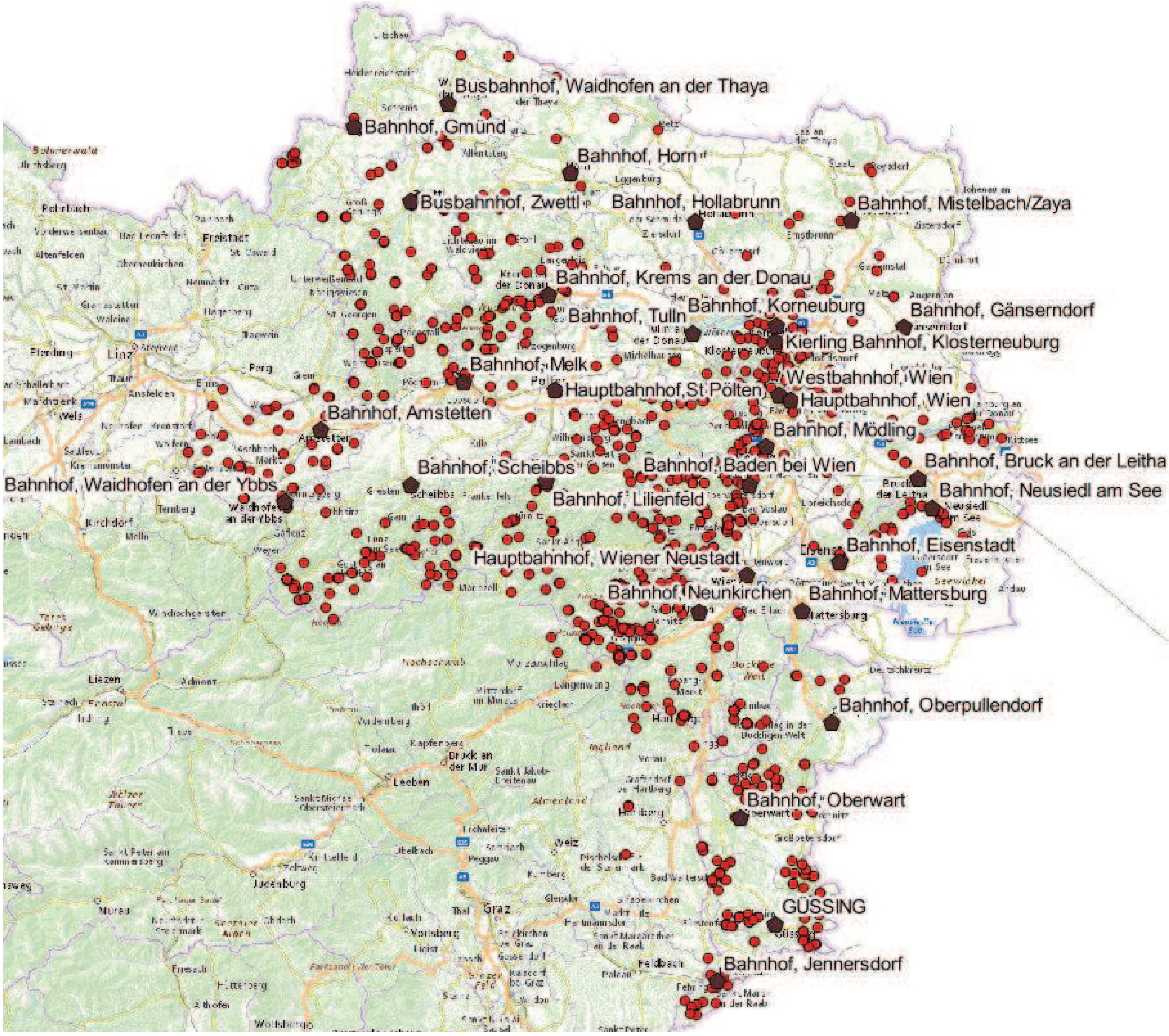

Fig. 3: Starting positions (brown pentagons) and hiking paths (red dots) used in the calculations (Wagner, 2015, p. 76). Background: Basemap.at

Fig. 4 shows the results of the reachability analysis for the starting location of Westbahnhof in Vienna (indicated by the star in the upper right sector). Green dots represent possible hiking locations. Yellow dots represent hikes that do not fit the selection criteria, i.e., the whole trip takes more than a day. A strange spatial pattern is visible between green and yellow dots: Sometimes the distance between a yellow and a green dot is small. The yellow dots then typically show hiking routes where the hiking itself already requires more than a day. Finally, the red dots represent hiking paths which are not reachable by public transport. There also seem to be a correlation between reachability and distance from the railway system (the thick lines in Fig. 4).

The balance between red and green dots may vary with the day. For example, on weekends some lines may not be served and thus the location is not reachable by public transportation. This is visualized in Fig. 5. The upper left image represents workdays (Monday - Friday). The upper right image represents Saturdays and the lower left image represents Sundays and public holidays. In the centre of the images (close to the starting point in Vienna), the differences are small. However, in remote areas patches of red dots pop up on Sudays. Thus, these locations cannot be reached at all using public transportation. However, some hikes that are possible on workdays turn to yellow on Saturdays and Sundays because the schedule of public transportation may start later or end earlier and the trip cannot be completed within a day.

ISBN 978-3-9504173-0-2 (CD), 978-3-9504173-1-9 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER

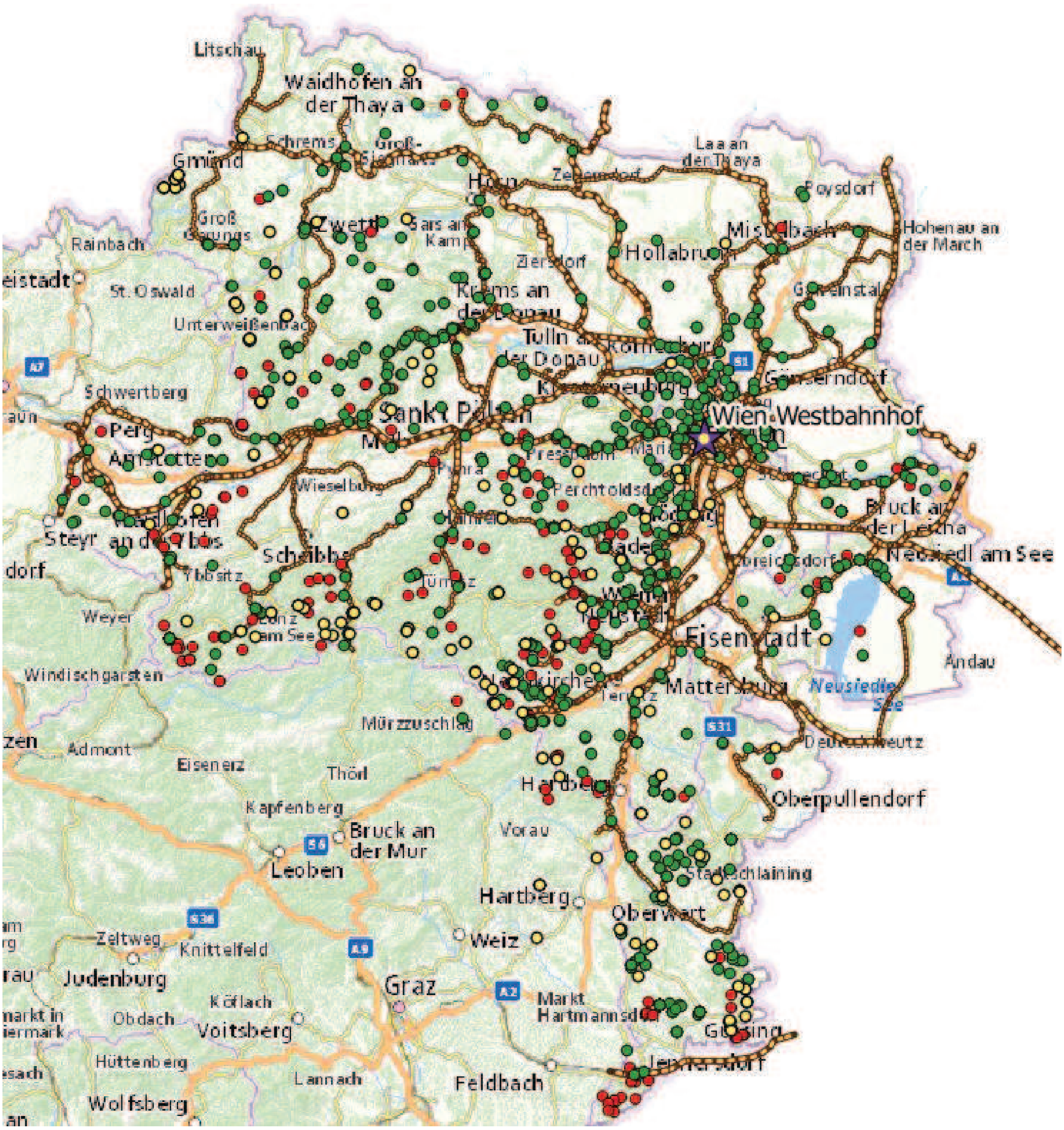

Fig. 4: Results for starting location Vienna, Westbahnhof. Background (Wagner, 2015, p. 77). Basemap.at

7 DISCUSSION AND CONCLUSION

In this paper a reachability analysis for ITS Vienna Region was developed to identify hiking possibilities that can be completed within a day including hiking and travelling by public transport. The first step was to develop a concept how to combine the data and which criteria have to be defined to meet the specifications of ITS Vienna Region. The results show the effect of the design decisions: User preferences were generalized and therefore the exclusion of hiking possibilities was mainly based on the availability of public transportation. However, once this data set is available, a selection based on arbitrary additional criteria like vertical extent, duration, or difficulty of the hike are easily possible in a web based end user application. The same is true for the length of the public transportation segments: while a five hour rail travel and a 30 minute hike would fit in a day, it will probably not be a clever choice. However, this step is just an application of standard multi-criteria selection (e.g., Achatschitz 2006).

One of the challenges was data supply. The quality of the analysis is determined by the quality of the used data. Both, up to date schedule data of a whole region or country and reliable data about the hiking paths are required. Schedule data typically is authoritative and reliable. The only difficulty is accessing the latest version. Data on hiking trips is more difficult. Some aspects like length or vertical profile are observable. Others, like duration of the hike vary with persons involved and the weather condition. In addition, there is no general procedure to collect, harmonize, and integrate this kind of data. Thus every data provider may have different coverage, different attributes, and even different classification based on the attributes.

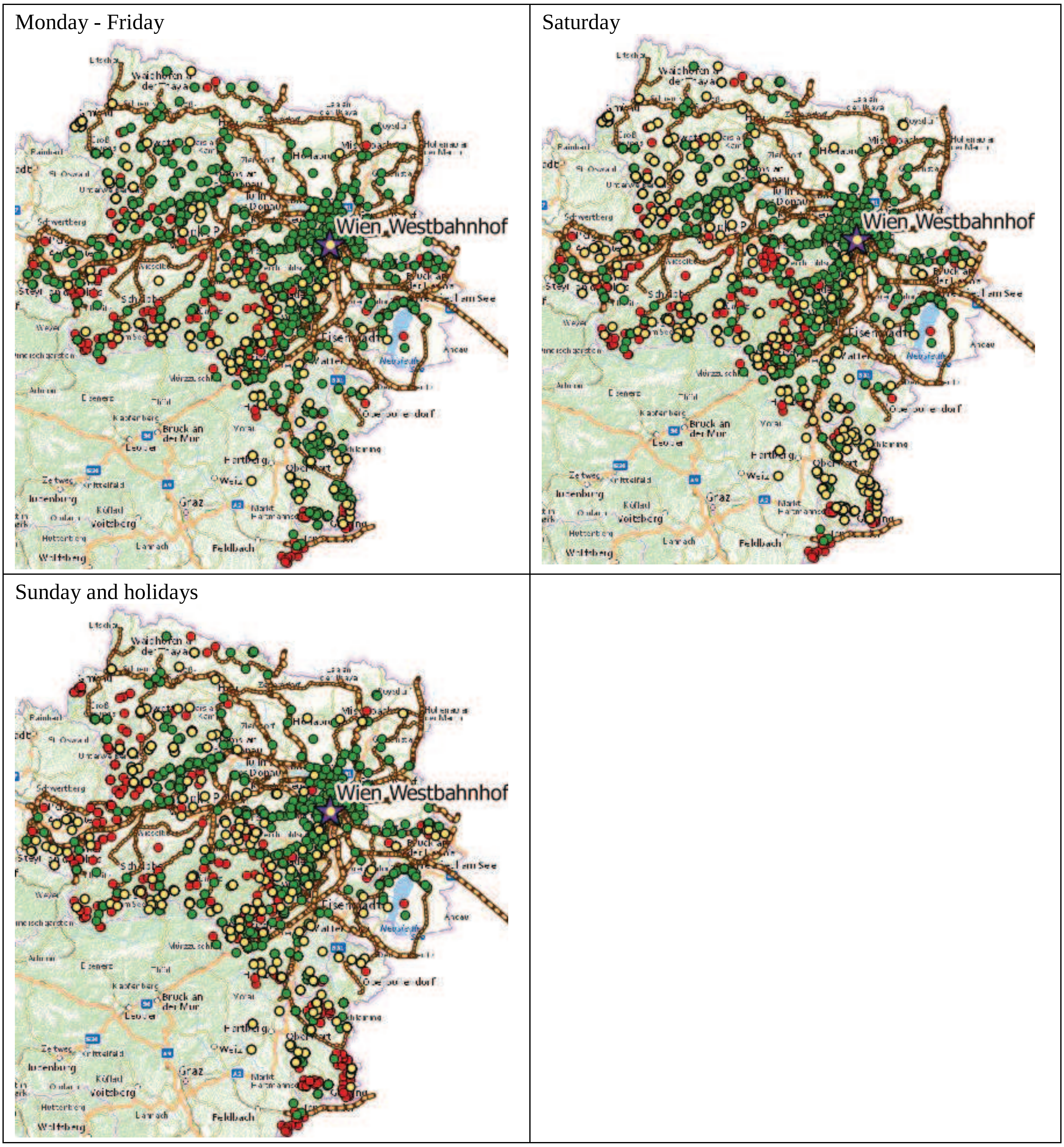

Fig. 5: Results for starting location Vienna, Westbahnhof (Wagner, 2015, p. 81). Background: Basemap.at

The situation gets worse when planning a transnational service. There is a single point of access for public transportation schedule data in Austria but cross-border trip planning typically involves numerous sources of information. The problems range from different service concepts and different time zones to varying national holidays or the shift of the weekend from Saturday and Sunday to Thusday and Friday in some countries. Addressing all these issues would be challenging.

Computation time is another challenge. Due to the numerous requests the calculation of the reachability of one starting station to all hiking paths lasts around 15 minutes for a workday or a Saturday or a Sunday. Thus, the average duration of a single request is approximately 30 ms. This necessitated the use of predefined starting stations. This is not an ideal solution for a flexible search instrument. Differentiation between elements that should be prepared in advance and elements that can be determined on the fly will be necessary.

It has been shown, though, that there are numerous hiking tracks around Vienna that can be reached by public transport. Making this kind of information visible to the citizens can help them make clever decisions and this is one of the main goals of smart cities or regions.

8 REFERENCES

ACHATSCHITZ, C.: Preference Based Retrieval of Information Elements. Proceedings of the Symposium on Spatial Data Handling – SDH (RIEDL, A.; KAINZ, W.; ELMES, G., eds.), Springer, pp. 215-228.

BAJRACHARAYA, B.; Cattell, D.; Khanjanasthiti, I.: Challenges and Opportunities to Develop a Smart City: A Case Study of Gold Coast, Australia. Proceedings RealCORP 2014 (SCHRENK, M.; POPOVICH, V.V.; ZEILE, P.; ELISEI, P., eds.), pp. 119-129, 2014.

GARAU, C.; MUNDULA, L.; SALUSTRI, A.: Smart Cities between Ethics and Aestetics. Proceedings RealCORP 2014 (SCHRENK, M.; POPOVICH, V.V.; ZEILE, P.; ELISEI, P., eds.), pp. 543-551, 2014.

MONTLEÓ, A.; RODRIGUEZ, G.; SANROMÀ, I.: Smart Cities as a Tool to Tackle Global Challenges. Proceedings RealCORP 2014 (SCHRENK, M.; POPOVICH, V.V.; ZEILE, P.; ELISEI, P., eds.), pp. 967-970, 2014.

NEIS, P.; ZIPF, A.; HELSPER, R.; KEHL, A.: Webbasierte Erreichbarkeitsanalyse – Vorschläge zur Definition eines Accessibility Analysis Service. Proceedings RealCORP 007 (SCHRENK, M.; POPOVICH, V.V.; BENEDIKT, J., eds.), pp. 985-995 2007.

WAGNER, S.: Computing the Reachability of Predefined Leisure Activities in Multi-Modal, Schedule Based Public Transportation Networks. Master Thesis, FH Technikum Wien, 117 p.

WENDT, W.; KALISCH, D.; VANDIEKEN, T.; ENGELBACH, W.: Smart Cities and ICT – Insights from the Morgenstadt Project. Proceedings RealCORP 2014 (SCHRENK, M.; POPOVICH, V.V.; ZEILE, P.; ELISEI, P., eds.), pp. 533-541, 2014.