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GIS-based identification and assessment of suitable meeting point locations for ride-sharing

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Abstract

Ride-Sharing or carpooling is a common means to utilize available but so far unused vehicle seat capacity. To establish a shared ride, it is necessary that the driver and the passengers agree on a meeting point. In most existing applications, the pickup location of a passenger is assumed to be on his or her doorstep. However, many people are willing to walk a certain distance to meet at a place where a safe and convenient boarding can be established, while at the same time the necessary detour of the driver can be kept acceptable. In this contribution we introduce an assessment scheme for meeting point locations based on results of an online survey retrieving the stated acceptance of meeting point locations and the relevance of the available facilities like parking places, seating, shelter and light. To this end, the infrastructure of a medium-sized European city is assumed to show exemplary how the amount and the distribution of suitable meeting point locations affects the performance and convenience of ride-sharing.

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Keywords: Ride-Sharing; Carpooling; Meeting Point; Rendezvous Point; Pickup Location; GIS Analysis;

1. Introduction

The need for mobility is constantly growing in many parts of the world. Individual motor car traffic still plays a major role to satisfy this demand, leading to congested streets and multiple environmental problems like smog and exhaustive carbon dioxide emissions. Low private car occupancy rates (the number of travellers per vehicle trip) amplify this problem due to a high amount of vehicles needed. In Germany, for example, car occupancies range from 1.9 for leisure trips down to 1.1 for daily commuting trips (INFAS and DLR, 2008). Altogether, in 2008 an average private car occupancy rate of 1.5 was observed, and nearly two third of all private car trips were made alone. In the US, nearly 9 out of 10 commuters ride alone in the car (89 % in 2012), and only 2 % of the transportation trips to work are done with three or more participants (U.S. Department of Transportation, 2015). Hence, it is conceivable to increase the occupancy of the vehicles by sharing rides in order to reduce the amount of cars driving on the streets.

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In fact, many services have become popular in the past to find travel partners to share a ride, often with a focus on a country or region. When looking at those services, two main concepts have to be distinguished: On the one hand, spare seats in trips are offered based on routes which are driven anyway, e.g. travelling to work. On the other hand, services like Uber or Lyft offer ride-sharing where the driver actually shares the ride because of financial purposes and not because of a similar destination, which results in a taxi-like service.

To establish a shared ride, the travellers (hereinafter divided into drivers and passengers) have to agree on a meeting point. In most existing applications, the passenger is assumed to be picked up at his or her doorstep. However, many people are willing to walk a certain distance in order to meet at a place where a safe and convenient boarding can be established while keeping the necessary detour for the driver acceptable. A recommendation of such points is especially helpful when a driver or a passenger is not familiar with the surrounding. It is conceivable that, in future, ride-sharing or navigation applications already contain a set of predefined meeting point locations for this use. Such points can, to a certain extent, even be designated by municipal traffic management to ease the establishing of shared rides.

In this context it has to be considered that ride-sharing is always connected with a certain amount of inconvenience, since detours and possible waiting times have to be accepted by all of the travellers. In order to encourage more people to share their rides, it is thus of major importance to keep the convenience at a high level. Besides for the ride itself (safe driving, sufficient space, etc.) this also holds for the meeting point location where either the driver or the passenger has to wait in the likely event of a non-simultaneous arrival. Local conditions and facilities like a good place for parking on the one hand and shelter, light or seating possibilities on the other hand influence the eligibility and thus the number of available convenient meeting point locations.

A ride-sharing system is commonly seen as a system to bring together travellers with similar itineraries and time schedules (Agatz et al., 2011). The goal of the ride-sharing problem is to create shared rides based on a demand and a number of available vehicles subject to various constraints, such as travel time or vehicle capacity limitations. It is closely related to the Dial-a-Ride-Problem (DARP), where the focus is on designing routes and schedules for a fleet of vehicles dedicated to transport passengers (Cordeau and Laporte, 2007). The main difference to the ride-sharing problem is that the DARP makes use of depot locations, whereas ride-sharing utilizes unique origins and destinations of the drivers. The ride-sharing problem can be classified into various groups of different usage (Furuhata et al., 2013). Numerous optimization strategies have been developed to solve the matching of drivers to passengers in different constellations (Agatz et al., 2012). A basic differentiation can be done between the static and the dynamic approach. While in the static case all requests are known in advance, the dynamic case allows the announcement of rides on short-notice (ad-hoc). A further differentiation of the ride-sharing system is the carpooling problem. It focuses mainly on daily commuting to a common work location and back and often contains the creation of schedules such that the driving task is fairly distributed among all carpooling members (Fagin and Williams, 1983; Naor, 2005; Huang et al., 2016).

In contrast to ride-sharing or carpooling systems with fixed pickup positions, the usage of flexible pickup and drop-off points has not gained much attention. Furthermore, the naming of such points is not consistent in the literature. Frequently used denominations are meeting point, pickup point, boarding point, ride-access point and rendezvous point, and, correspondingly, drop-off point and leaving point. For the sake of consistency we will use the denomination *meeting point* and *divergence point* in the following to emphasize that people are travelling together on the intermediate part.

A straightforward way to include meeting points in calculations is using a (randomly generated) time for each passenger to reach a meeting point. In a carpooling club model presented by Correia and Viegas (2011), meeting points are included in this way. They used random times from an interval between 0 and 15 minutes for both meeting and divergence point. In an earlier work they included also walking distances in a Monte-Carlo ride-sharing simulation, but limited it to the divergence point before walking to work (Correia and Viegas, 2010). If an actual location should be determined and the route of the driver is fixed, the search can be limited to points along the given route. O'Sullivan et al. (2000) presents a GIS-based method to determine such boarding points along bus routes by using isochrones to analyse the accessibility. A similar agent-based approach in the scope of ride-sharing by Rudnicki et al. (2008) determines also leaving points with the help of communication among the riders.

A flexible route of the driver is more realistic in a ride-sharing scenario and offers the possibility to meet halfway with the passenger, but the number of possible solutions is significantly larger. Aissat and Oulamara (2014, 2015) propose an approach for the case when the assignment of drivers and passengers is already fixed, but the route is flexible. Given a driver and a rider route, they find intermediate meeting locations in a real street network indicating the part of the trip that can be travelled together. The objective is to minimize the total travel costs subject to time constraints, but they make no assumptions on how the intermediate locations are actually reached.

Balardino and Santos (2016) propose a greedy and an iterated local search heuristic to assign passengers to drivers at meeting points in a real street network, given that the possible detour length of the driver and the vehicle capacity is limited. Each passenger defines a set of feasible meeting points which they call *close enough points*, determined by a euclidean distance threshold. In the work of Stiglic et al. (2015), potential benefits of using meeting points are investigated by a computational study based on real-world demand data. All distances are based on the bee line, and the meeting points are randomly generated for each transport zone. In the experiments they could show that the introduction of meeting points can improve several metrics like the percentage of matched participants and mileage savings.

Another scope is the dynamic ride-sharing, where requests occur ad-hoc. Rigby et al. (2013) developed a user interface technique called *launch pads*, showing passengers the area in which they could potentially be picked up by a driver. The idea is based on the fundamentals of time-geography and space-time-prisms (Hägerstraand, 1970; Miller, 1991), a theory that is often applied to dynamic ride-sharing models (Raubal et al., 2007; Winter and Nittel, 2006). Launch pads also have the advantage of ensuring privacy to the users, since a contract can be established without a need for revealing the actual locations since only the possible pickup locations have to be published. Moreover, the human-machine interaction of launch pads is an important aspect that has to be considered in terms of usability, since possible pickup locations can be visualized as points, lines or areas (Rigby and Winter, 2015, 2016).

However, the actual determination of eligible meeting points in a real city environment is often neglected. Many existing models use either the euclidean plane to simulate meeting points or use street intersections in the routing network. This often results in locations with heavy traffic where a secure boarding is almost impossible. Hence, other evaluation criteria than time or distance minimization are necessary to focus on convenient meeting point locations. As an example, parking possibilities or facilities to improve the waiting time (seating, shelter) can be of major importance regarding the eligibility of a meeting point. One way to determine such points is crowd sensing (Heipke, 2010). Hansen et al. (2010) presented a web-based framework where meeting points could be created, rated and improved by the ride-sharing community itself. Within a short period of 10 months, almost 400 *ride access points* have been created by users all over Germany, and more than 1000 users used this network of meeting point suggestions for the planning of their rides. However, the determination of such points by crowd sensing needs a large community and can hardly cover all regions. Thus, an automatic extraction and rating of feasible meeting points is necessary to provide comprehensive meeting point recommendations.

In this contribution we propose a GIS-based method to identify potentially feasible real-world meeting points and introduce an assessment scheme to rate them. The workflow is applied on a medium-sized European city. Subsequently, a simulation of shared rides is conducted to show exemplary how the amount and the distribution of suitable meeting point sets affect the usage of ride-sharing. For this, different meeting point sets are created to simulate the effect of a limited amount of officially designated meeting point places. An online survey is used as input for realistic user preferences, showing the stated acceptance of meeting point locations and the relevance of the available facilities. The major outcome provides an estimation about the necessary amount and distribution of meeting point locations in a city environment.

2. Study area and data

For this research we used the city of Braunschweig, Germany, as data basis. It is a medium-sized city with 250.000 inhabitants and a typical European city structure. The centre is dominated by the historical core with an irregular street network and the pedestrian precinct. It is surrounded by a densely populated area and a more regular street network. In

(a) Routing network (Source: OpenStreetMap)

(b) Connected origins and destinations

Fig. 1: Investigation area: City of Braunschweig, Germany

the outskirts, the population density is significantly lower, and there are additionally some industrial areas. Two main types of arterial roads can be found: straight streets from outside into the city centre, and a ring structure surrounding the inner city. The outer ring is formed by motorways, except of the eastern side.

The street network has been obtained from OpenStreetMap and was transformed into a routing-enabled graph $G = (V, E)$ consisting of vertices V and edges E. As weights, the driving time t_e^D and walking distance $dist(e)$ is calculated for every edge $e \in E$. As driving speed, the corresponding maximum allowed speed multiplied with 0.9 is assumed. The walking time t_e^W is determined by assuming a walking speed of 4.8 km/h, using the mean walking speed for active-transport walking trips revealed by Millward et al. (2013). The traversal of footpaths, cycle ways and stairways is prohibited for vehicles. Likewise, pedestrians are not allowed to walk on major roads or motorways. Further, all other geodata used in this paper (like parking places, fuel stations, amenities etc.) is obtained from OpenStreetMap, with two exceptions: A Level-of-Detail 1 building model of the city of Braunschweig for the demand creation, and a point dataset containing street lamps in the city district. Those two datasets are provided by the municipality of the city of Braunschweig (Municipality of Braunschweig, 2016). The building model is used as potential origin and destination location of the travellers. For the origins, all residential buildings are considered, while for the destinations working place buildings are used. A minimum size threshold of 100 m^2 is further applied to exclude small huts and too small detached houses from being chosen. Finally, all considered buildings are connected to the street dataset to model the whole path of the user (see figure 1b). In the end, the network consists of 88381 nodes and 99497 edges, including 26845 home and 2615 work locations.

3. Methods

The workflow of the proposed GIS-based approach consists of four parts: the identification, assessment and filtering of meeting point locations and a simulation. For the GIS operations, QGIS, PostGIS and pgRouting have been used. All distances are determined by a routing on G with the Dijkstra algorithm provided by the pgRouting library.

3.1. Identification of meeting point candidates

In this initial step, feasible meeting point candidates $\mu \in M$ are automatically identified in the available map data by a GIS workflow. The identified set M is also used as set of potential divergence points $\delta \in \Delta$, so that $\Delta = M$. For our work, the following places are considered:

- Publicly accessible parking places without parking fees
- Side road intersections (with all adjacent roads having a maximal speed of 30 km/h)
- Turning areas (at the end of a cul-de-sac)
- Fuel stations

Obviously, this preselection is not complete, since many more options for good meeting points exist in the real world. However, the restriction to the four reasonable point types limits the amount of available meeting locations to a controllable amount and makes modelling possible. An example can be seen in Fig. 2a. Parking areas and fuel stations are converted to point features using the centroid of the original geometry. Each identified candidate is further connected to the street network graph G with a connecting edge between the meeting point location and the closest point on the closest edge. If the closest edge is e.g. a footpath and hence not reachable by vehicles, a second edge is inserted to the closest drivable edge. The same is applied vice versa for edges not accessible by foot.

3.2. Assessment of meeting points

Subsequently, the identified and connected meeting point candidates are assessed based on the facilities accessible in the direct surrounding. Influencing factors for the assessment are:

- Parking quality
- Illumination
- Shelter
- Seating

The parking quality q_μ^P is assessed by a manual estimation. Parking places and turning areas have the best rating ($q_\mu^P = 3$), fuel stations are intermediate ($q_\mu^P = 2$) and street intersections are intuitively inferior ($q_\mu^P = 1$). The convenience facilities (illumination, shelter and seating opportunities) are represented as binary value $b_\mu^{facility} \in \{0, 1\}$ if a corresponding object is within a certain threshold. For our experiments, we used a value of 25 meter around the object. For illumination, the street lamp dataset was used to determine the closest light source. Objects that give shelter are for example canopies, telephone booths, bus/tram shelter or various other types of shelter appropriately tagged with the attribute *shelter* in OpenStreetMap. Similarly, different objects can provide seating, like park benches or bus/tram stops, and various other objects tagged as *seating* in OpenStreetMap.

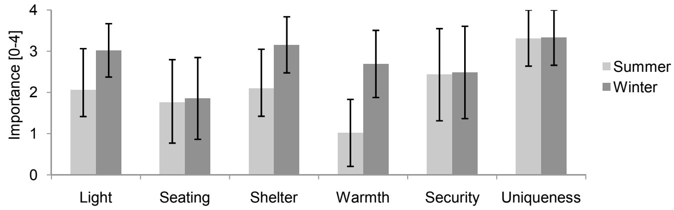
3.3. Reduction of meeting point candidates

To compare different meeting point sets, the previously created set is filtered by different methods:

- Random selection (The meeting points are randomly chosen from the set)
- Passenger rating (The meeting points are rated by fictitious demand, and points with high scores are used first. Since the scores are summed up, the meeting points are also distributed more among the estimated demand)
- Proximity to arterial roads (Meeting points that are located close to arterial roads (motorway, primary, secondary roads) are preferred)

The filtering process depends on the desired number of available meeting point. If n points are required, then the first n points are selected from the given sorted lists (except the random selection).

(a) Identified meeting point candidates



(b) Stated relevance of meeting point facilities

Fig. 2: Meeting point identification and user study results

3.4. Evaluation

The generated candidate set represents a possible situation in a city where a limited amount of meeting points are designated or saved in navigation applications. These sets are evaluated regarding how many and where meeting points should be placed to satisfy the demand. For the evaluation, a randomly generated demand scenario is used to simulate shared rides in the city. We focus on the morning commute with people travelling from their homes to work.

3.4.1. Demand

We assume a set of trip requests R. Each trip request $r \in R$ consists of an origin v_r^O, a destination v_r^D, a time of earliest departure t_r^{ED} and a time of latest arrival at the destination t_r^{LA}. The set of trip requests R can further be divided into subsets of drivers $d \in D$ and passengers $p \in P$. To simplify the model to a reasonable extent we use fixed driver and passenger roles and assume only static trip requests, that is, all trips are known in advance. The temporal appearing follows a Gauss distribution, centred at 07:00 with a standard deviation of 30 minutes to simulate a busy morning commute peak. Each traveller has a fixed time budget of 60 minutes to reach the destination.

The spatial distribution is based on a weighted sampling of the building data, either as home or as working place. The probability of a building to be chosen as origin or destination depends on its volume, i.e. bigger buildings have a higher chance to be selected than small buildings, following the assumption that there is a correlation between the volume and the available living and working paces. To prevent huge factory buildings to be chosen disproportionately often, the volume was capped at a threshold of 10000 m^3. Passengers start and end their trip directly at their origin building, and drivers start and end at the closest node that is accessible by vehicles.

Each passenger is further equipped with a set of individual preferences about walking ability and meeting points. The maximum acceptable walking distance $dist^W(p)$ for each passenger is estimated by sampling from a Gauss distribution with the mean value at 670 meters and a standard deviation of 300 meters, following roughly the findings of Millward et al. (2013) for active-walking trips. Further, each passenger defines individual preferences about the importance of certain properties of meeting points. To get realistic values, we conducted an online user survey with 98 participants who have been asked about their personal preference regarding several meeting point characteristics. The results are visualized in fig. 2b. At this point it has to be remarked that they reflect naturally characteristics specific to Germany. The survey participants could assign each property like seating, shelter or security an importance value between 0 and 4. Further, we distinguish between winter and summer times. In this work we use only the meeting point facilities illumination, shelter and seating during summer times for the evaluation model. Warmth and security are not easy to identify in map data, so that only an on-site inspection could deliver the needed values. A unique location is most important to the user, but since we already use only clearly distinguishable locations, this aspect can be regarded as fulfilled. The used distribution is listed in table 1. Each passenger is hence assigned three concern values $c_p^{light}, c_p^{seating}, c_p^{shelter} \in \{0-4\}$ based on weighted random assignment.

Table 1: Pattern for the distribution of meeting point facility preference values.

Importance value	Illumination	Seating	Shelter
0	14,4 %	18,5 %	10,3 %
1	17,5 %	24,7 %	20,6 %
2	25,7 %	23,7 %	26,8 %
3	31,9 %	27,8 %	32,9 %
4	10,3 %	5,1 %	9,2 %

For each passenger $p \in P$, a reachability analysis is performed to determine all reachable meeting points starting from the origin and from the destination and constrained by the maximum walking distance $dist^W(p)$. All accessible meeting points $\{\mu \in M \mid dist(\mu \to v_p^O) \leq dist^W(p)\}$ are then rated to determine an individual satisfaction value. Three different ratings are applied: for the walking length (1), the satisfaction about the facilities (2) and the parking quality (3). At all three values, one is the best possible rating and zero the worst. The resulting total satisfaction value s_μ is determined by a "spatial distance" to the least convenient value (4). This allows an additional weighting of the three input parameters, and a meeting point is not directly excluded if one of the three ratings are zero. Note that for divergence point ratings s_δ only the walking length and parking quality are considered, since meeting point facilities like shelter and seating are useless at this point (5).

$$s_\mu^{path} = 1 - \frac{dist(\mu \to v_p^O)}{w_p} \tag{1}$$

$$s_\mu^{facility} = \max\,(1 - \frac{(1 - q_\mu^{light})c_p^{light}}{4} - \frac{(1 - q_\mu^{seating})c_p^{seating}}{4} - \frac{(1 - q_\mu^{shelter})c_p^{shelter}}{4}, 0) \tag{2}$$

$$s_\mu^{parking} = \frac{q_\mu}{3} \tag{3}$$

$$s_\mu = (s_\mu^{path})^2 + (s_\mu^{facility})^2 + (s_\mu^{parking})^2 \tag{4}$$

$$s_\delta = (s_\delta^{path})^2 + (s_\delta^{parking})^2 \tag{5}$$

3.4.2. Matching

To simulate shared rides, passengers are matched to drivers using meeting and divergence points. We formulate the assignment problem as a bipartite graph and solve it with mixed-integer linear programming (MILP) using Gurobi Optimizer. This principle is a common way to tackle this problem (Agatz et al., 2011). The used approach is a modification of the formulation of Stiglic et al. (2015). Let X be the set of all possible matches, represented as edges in the bipartite graph, and let X_d and X_p be the subset of X with the matches including driver d and passenger p, respectively. A match consists of a driver $d \in D$ and a passenger $p \in P$, meeting at node $\mu \in M$, then travelling together to node $\delta \in \Delta$ where they separate again. Naturally, only reachable meeting and alighting points are necessary to consider. To speed up the algorithm, only the 10 best rated meeting and divergence points, respectively, are considered for each passenger. However, this limitation has nearly no effect on the final result, as further experiments showed. Naturally, the match is only possible if the time constraints allow a pickup and drop-off. The earliest possible departure time at the meeting point t_μ^{ED} and the latest possible arrival time at the divergence point t_δ^{LA} are calculated by

$$t_\mu^{ED} = max(t_d^{ED} + t^D(v_d^O \to \mu), t_p^{ED} + t^W(v_p^O \to \mu)) \tag{6}$$

$$t_\delta^{LA} = min(t_d^{LA} - t^D(\delta \to v_d^D), t_p^{LA} - \delta \to t^W(v_p^D)) \tag{7}$$

If $t_\mu^{ED} + t^D(\mu \to \delta) \leq t_\delta^{LA}$, both driver and passenger can reach the destination on time, so that the ride is considered time-feasible. For each possible match, a binary decision variable b_x is stored, indicating whether the connected match is established or not. Each edge is assigned a weight w_x representing the benefit of the match and calculated by a sum of three input values (9): the satisfaction about the meeting point μ (4), the satisfaction about the divergence point δ (5) and the squared normalized driver detour value (8). The result represents the overall eligibility for a specific driver - passenger match using meeting point μ and divergence point δ. The formulation allows an optional weighting of all influencing parameters if specific aspects needs to be emphasized.

$$s_d(\mu \to \delta) = \frac{t^D(v_d^O \to v_d^D)}{t^D(v_d^O \to \mu \to \delta \to v_d^D)} \tag{8}$$

$$w_x = s_\mu + s_\delta + s_d(\mu \to \delta)^2 \tag{9}$$

The objective function of the integer program is

$$max\, z = \sum_{x \in X} = b_x \cdot w_x \tag{10}$$

subject to

$$\sum_{x \in X_d} b_x \leq 1 \; \forall d \in D \tag{11}$$

$$\sum_{x \in X_p} b_x \leq 1 \; \forall p \in P \tag{12}$$

The constraints assure that each driver is only matched to at most one passenger. This assumption limits the search space so that the problem is solvable in an appropriate time.

4. Results

We conducted several experiments using the evaluation scheme described in the previous section to determine how the availability of meeting point candidates affects the usage of ride-sharing. A set of 200 drivers and passengers was created and used throughout the following results for a comparison. Three examples of chosen points can be seen in the maps of figure 3.

To simulate a predefined set of designated meeting points, we limited the amount of available meeting points by choosing a subset. The results can be seen in the graphs at figure 4. Figure 4a shows that an increase of available meeting point locations leads to more matched passengers. This observation follows the findings of Stiglic et al. (2015). If the highly ranked subset is used, the matching rate is significantly lower until approximately 1000 available meeting points. An explanation can be that mostly meeting points in the densely populated inner city area are chosen in the first place, and only very few locations are available at the residential areas out of range. In figure 4b, the satisfaction values increase constantly, since with more available meeting points better points can be chosen. If highly ranked locations are chosen first, the average satisfaction is naturally higher.

Figure 4c shows the detour of the matched drivers as percentage of the route without a passenger. The differences between the meeting point sets are small, but there is nevertheless a trend that if locations close to arterial roads are used, the detour distance is smaller (at 1500 available meeting points about 12 %). In figure 4d, the average walking distance sum (to the meeting point and from the divergence point) is visualized. We can see that the distance decreases with increasing number of meeting points, since passengers can choose closer locations when they are available. Here, the set with locations close to arterial roads leads to the longest paths, which is a downside to the decreased driver tour length. In contrast, using highly ranked locations in the first place, the walking distances decrease because people prefer to walk less and hence rate those points better.

In all graphs a saturation effect can be seen where a further appending of meeting points does not significantly improve the investigated metrics. In this case study, approximately 1000 designated places would be enough to match above 80 % of the passengers and to reduce the mean walking distance of the customers to approximately 600 meters. Only the satisfaction can be further improved, but this effect can also be achieved by increasing the quality, i.e. providing better meeting point facilities in the city.

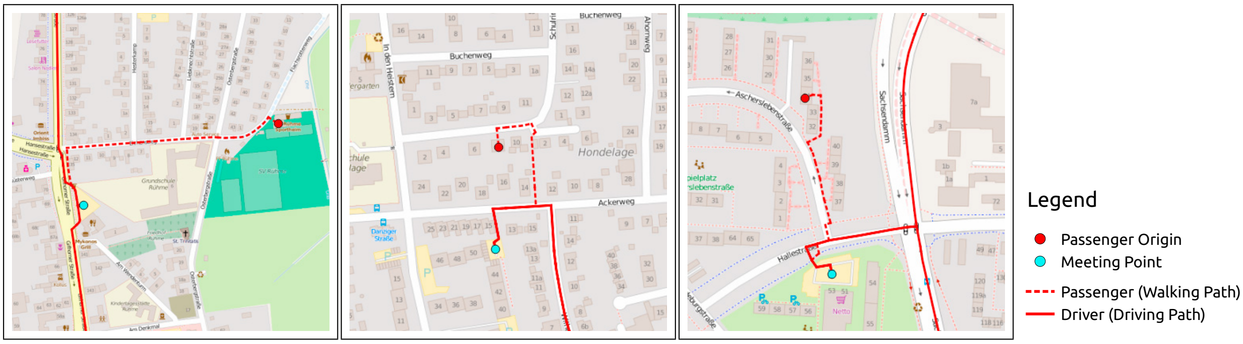
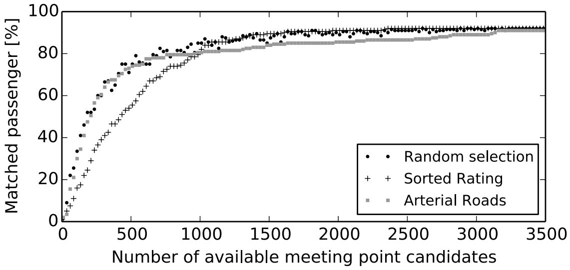
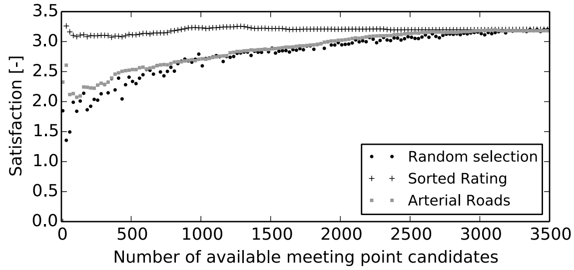


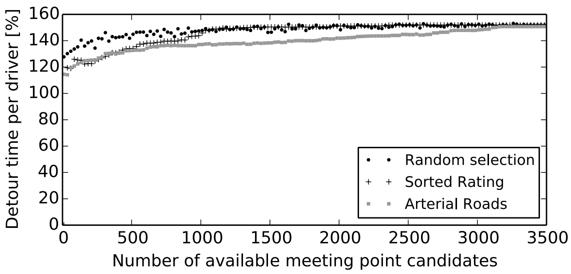
Fig. 3: Map examples with passenger origins and walking path to the meeting point (Background: OpenStreetMap)



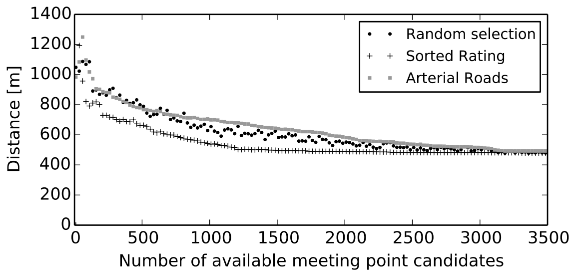
(a) Number of matched passenger



(b) Meeting and divergence point satisfaction



(c) Driver detour ratio



(d) Passenger walking distance (Sum of two ways)

Fig. 4: Results of the matching based on different numbers of available meeting points

5. Discussion

From a visual inspection, the proposed meeting and alighting points look reasonable. Often, parking places in the vicinity of passenger origins are used, and sometimes the driving paths change significantly if the entering of residential areas can be avoided, just like what could be expected in a real world behaviour. However, the presented approach is naturally highly dependent on the quality of the provided map data. In the case of Braunschweig, the quality of the OpenStreetMap data is very good with lots of objects mapped and corresponding details tagged appropriately. This is certainly not the case in many other regions, so that a direct transfer to other cities is at least arguable. Further, even with many objects accurately tagged, it is not always possible to determine if a location really offers the desired facilities like shelter, seating and light, or if they can be identified in the map. Nevertheless, with more and more map data that is available by crowd sourcing the quality of meeting point assessment will improve gradually. In addition, user ratings as proposed by Hansen et al. (2010) can provide further valuable input.

6. Conclusion

Ride-Sharing is an efficient way to improve the traffic situation by lowering the number of necessary vehicles when people travel together. Further, the usage of meeting points can be beneficial since the drivers do not have to pick up the passengers at the doorstep and drive unnecessary detours. However, in a real city environment, it is necessary to consider the local situation to determine convenient meeting points, enabling a secure parking and boarding and making the waiting time as comfortable as possible. In this paper we present an approach to identify and rate real-world meeting points. We further evaluated the setting with a simulation of fictitious demand, but based on preferences from a user study. The evaluation shows that the user satisfaction as well as the amount of matched participants is dependent on the amount and spatial distribution of meeting points. However, a saturation effect can be observed, showing that a limited amount of labelled meeting points in a city is sufficient to meet the demand. Locations with facilities like light, shelter and seating can further improve the overall satisfaction of the user.

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