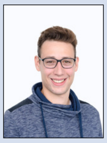

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Subject Area	Internet Technologies and Applications
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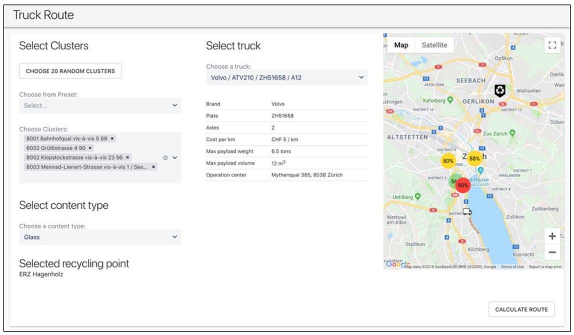
Truck Route

Smart Routing of a Logistics Platform



Truck Route

Select Clusters

CHOOSE 20 RANDOM CLUSTERS

Choose from Preset: Select...

Choose Clusters:
8001 Bahnhofquai vis-à-vis 5 88 ×
8002 Grütlistrasse 4 90 ×
8002 Klopstockstrasse vis-à-vis 23 56 ×
8003 Meinrad-Lienert-Strasse vis-à-vis 1 / See... ×

Select content type

Choose a content type: Glass

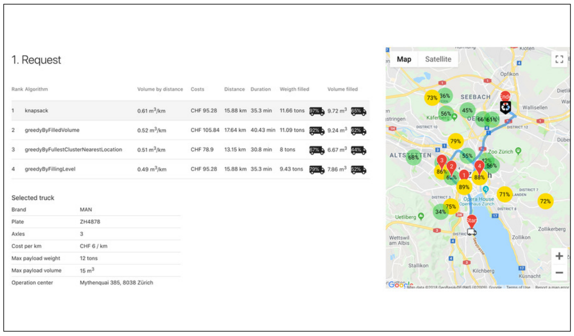
Selected recycling point
ERZ Hagenholz

Select truck

Choose a truck: Volvo / ATV210 / ZH51658 / A12

Brand	Volvo
Plate	ZH51658
Axles	2
Cost per km	CHF 5 / km
Max payload weight	6.5 tons
Max payload volume	12 m^3
Operation center	Mythenquai 385, 8038 Zürich

The form in which the user is able to select container clusters, truck and content type and send the request to the API.



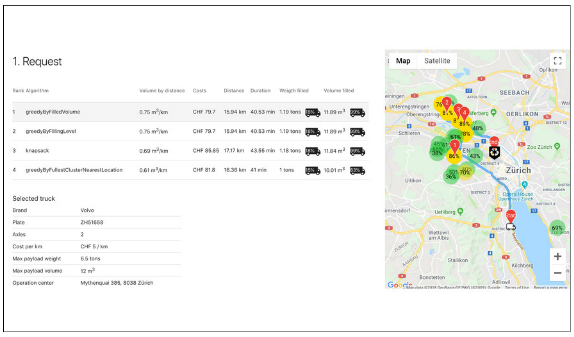
1. Request

Rank	Algorithm	Volume by distance	Costs	Distance	Duration	Weigth filled	Volume filled
1	knapsack	0.61 m^3/km	CHF 95.28	15.88 km	35.3 min	11.66 tons 97%	9.72 m^3 65%
2	greedyByFilledVolume	0.52 m^3/km	CHF 105.84	17.64 km	40.43 min	11.09 tons 92%	9.24 m^3 62%
3	greedyByFullestClusterNearestLocation	0.51 m^3/km	CHF 78.9	13.15 km	30.8 min	8 tons 67%	6.67 m^3 44%
4	greedyByFillingLevel	0.49 m^3/km	CHF 95.28	15.88 km	35.3 min	9.43 tons 79%	7.86 m^3 52%

Selected truck

Brand	MAN
Plate	ZH4878
Axles	3
Cost per km	CHF 6 / km
Max payload weight	12 tons
Max payload volume	15 m^3
Operation center	Mythenquai 385, 8038 Zürich

The result view in which the different algorithms can be compared to each other.



1. Request

Rank	Algorithm	Volume by distance	Costs	Distance	Duration	Weigth filled	Volume filled
1	greedyByFilledVolume	0.75 m^3/km	CHF 79.7	15.94 km	40.53 min	1.19 tons 18%	11.89 m^3 99%
2	greedyByFillingLevel	0.75 m^3/km	CHF 79.7	15.94 km	40.53 min	1.19 tons 18%	11.89 m^3 99%
3	knapsack	0.69 m^3/km	CHF 85.85	17.17 km	43.55 min	1.18 tons 18%	11.84 m^3 99%
4	greedyByFullestClusterNearestLocation	0.61 m^3/km	CHF 81.8	16.36 km	41 min	1 tons 15%	10.01 m^3 83%

Selected truck

Brand	Volvo
Plate	ZH51658
Axles	2
Cost per km	CHF 5 / km
Max payload weight	6.5 tons
Max payload volume	12 m^3
Operation center	Mythenquai 385, 8038 Zürich

In this result the greedy by filled volume algorithm performed best according to our chosen metric m[sup]3[/sup]/km.

Introduction: Recycling containers need to be regularly emptied using trucks. TrackOrTruck, a new startup, wants to support the process of emptying these containers. To achieve this, the recycling containers will be equipped with sensors, which will transmit their current filling level to the cloud. The collected data opens up new possibilities: As of now, an operator has to plan a route for the truck driver based on his experience. The goal of this project is to help the operator by providing different, optimized routes using the collected data. The route should be optimized for the ratio between the amount loaded and the kilometers driven. In addition, the truck should not necessarily be filled to the maximum.

Procedure / Result: Two applications were developed during this thesis:

A HTTP API which calculates routes. The client sends the API a request, including a truck, a collection of containers and the start and end point of the route. Based on the data provided, the API returns multiple possible routes. The API was developed using TypeScript and deployed as a stateless AWS Lambda function.

The process by which the routes are generated can be divided into three steps:

- The container cluster collection are first analyzed. For analyzing, a dynamic programming in-advance algorithm to solve our version of the knapsack problem and a greedy algorithm using three different prioritization strategies are used. Depending on the strategy, the containers nearby, the containers with the highest filling level or the containers with the most volume are prioritized. This results in four different subsets of the original container cluster collection.
- For each subset an API request is sent to the Google Directions API. The Directions API approximates the traveling salesman problem and returns a route where the container clusters are visited in an order as to minimize the travel time of the route.
- For each received solution of the Directions API, six key figures are calculated, such as load per kilometer, cost and duration of the journey. Based on the key figure load per kilometer the solutions are sorted and returned, best first.

A web app to demonstrate and test the API. A user can select container clusters, a truck and a content type and send the request to the APP. After receiving the response the different route candidates are displayed with all of their key figures and a map showing the route. The web app was developed using TypeScript and the frontend library React.

Result: The result is a fully tested and robust API that is vertically and horizontally scalable and allows to calculate optimized routes. To meet our high quality requirements we followed state of the art coding guidelines. The API is also flexible and works for all regions of the world covered by the Directions API. It currently supports glass and waste containers. In the future the variety of supported container contents could be easily extended.

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