Dette udvidet resumé er udgivet i det elektroniske tidsskrift
Artikler fra Trafikdage på Aalborg Universitet
(Proceedings from the Annual Transport Conference at Aalborg University)
ISSN 1603-9696
https://journals.aau.dk/index.php/td

trafikdage
NY VIDEN & NETVÆRK

Analysis of Danish Truck Tolling GPS Data

Mads Werngreen, madswerngreen@outlook.dk
Carlos M. Lima Azevedo (DTU), Jeppe Rich (DTU), Thomas Ross (Vejdirektoratet)

Abstract

This study presents an analysis of GPS data obtained from the Danish truck tolling system, covering a one-week period with more than 800 million observations across over 60,000 trucks. The analysis extracts mobility patterns from high-resolution data by segmenting raw GPS sequences into trips. These trips are subsequently used in a simulation-based framework to estimate future charging demand.

The simulation is based on a simplified range-based model, where charging events emerge endogenously from observed driving behavior. Spatial clustering is applied to identify areas of concentrated demand, and these clusters form the basis of an optimization problem in which cluster locations serve as candidate sites for new charging infrastructure.

The results reveal spatial and temporal concentration of charging demand along major transport corridors and during daytime hours. The findings highlight regions with limited existing coverage as key candidates for infrastructure expansion. While the model relies on simplified assumptions, it provides a scalable and data-driven approach for planning charging infrastructure under electrification scenarios.

Introduction

Traditional analyses of transport patterns are typically based on aggregated data or model assumptions, which may not fully capture real-world driving behavior. The introduction of a national road tolling system for trucks in Denmark enables the collection of high-resolution GPS data, providing a unique opportunity to analyze transport patterns based on observed behavior.

This study presents a data-driven framework for analyzing mobility patterns and estimating future charging demand for electric trucks. The approach is based on segmenting GPS data into trips, simulating charging demand based on observed driving behavior, and applying optimization techniques to identify potential locations for new charging infrastructure.

Data

The analysis is based on GPS data collected through the Danish truck tolling system. The dataset covers a one-week period and contains more than 800 million observations from over 60,000 trucks, with a temporal resolution of approximately 5 seconds.

Each observation includes timestamp, geographic position, speed, and heading. The data is not map-matched, which simplifies processing but introduces some uncertainty in position accuracy. Additionally, GPS transmission typically stops when vehicles leave Denmark, meaning international trips are only partially observed.

Method

The method section is divided into three parts: Segmentation of Trips, Simulation of charging demand, and Clustering and optimization

Segmentation of Trips

Raw GPS trajectories are segmented into trips based on stop detection. A vehicle is classified as stationary using a smoothed speed threshold, and stops longer than a specified duration define trip boundaries. Additional rules are applied to avoid incorrect segmentation due to short stops, rest areas, ferry crossings, and temporary congestion. This ensures that the identified trips reflect actual transport activity.

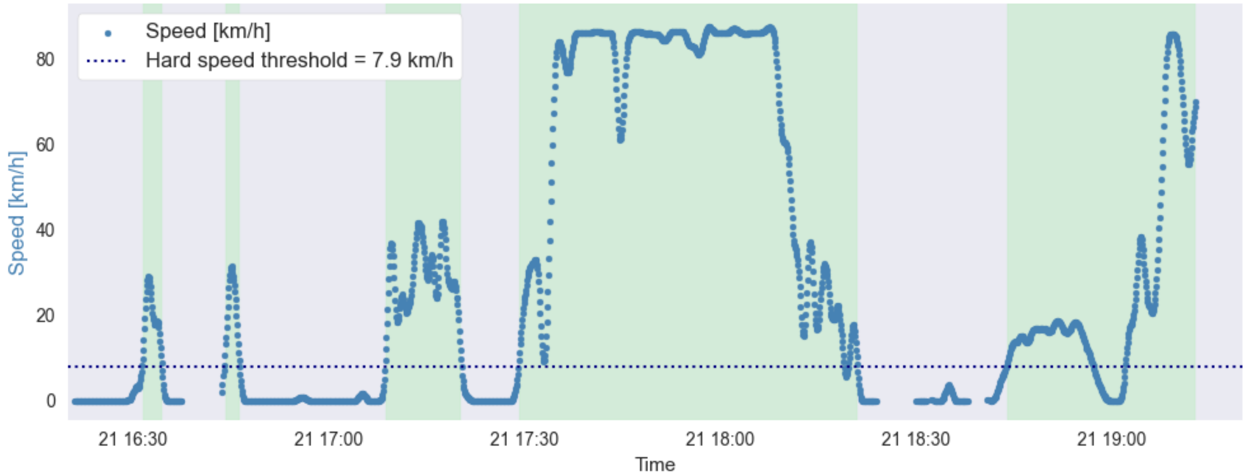

Figure 1: Segmentation of trips using a smoothed speed threshold

Simulation of charging demand

The identified trips are used as input to a simulation model that estimates charging demand under an electrification scenario.

Battery state is modeled implicitly using a fixed driving range, which is reduced according to the distance traveled. When charging occurs, the battery is assumed to be fully recharged.

Charging events occur in two cases:

- during long stops (depot charging)
- when the remaining range is insufficient to complete the next trip (public fast charging)

The analysis focuses on charging events triggered by insufficient range, as these represent demand for public charging infrastructure. Charging demand is therefore not predefined, but emerges directly from observed driving behavior

Clustering and optimization

Charging events are spatially clustered using the DBSCAN algorithm to identify areas of concentrated demand. These clusters form the basis of an optimization problem, where the objective is to minimize the weighted distance between demand locations and their nearest charging station. Weights are based on the number of charging events in each cluster, ensuring that both high-demand areas and underserved regions are considered.

Results

The results show a spatial concentration of charging demand along major transport corridors and near urban areas. This indicates that charging demand is closely linked to existing traffic patterns. Temporal analysis reveals a clear daily pattern, with most charging events occurring during daytime hours. This suggests that charging demand is primarily driven by operational constraints during active driving

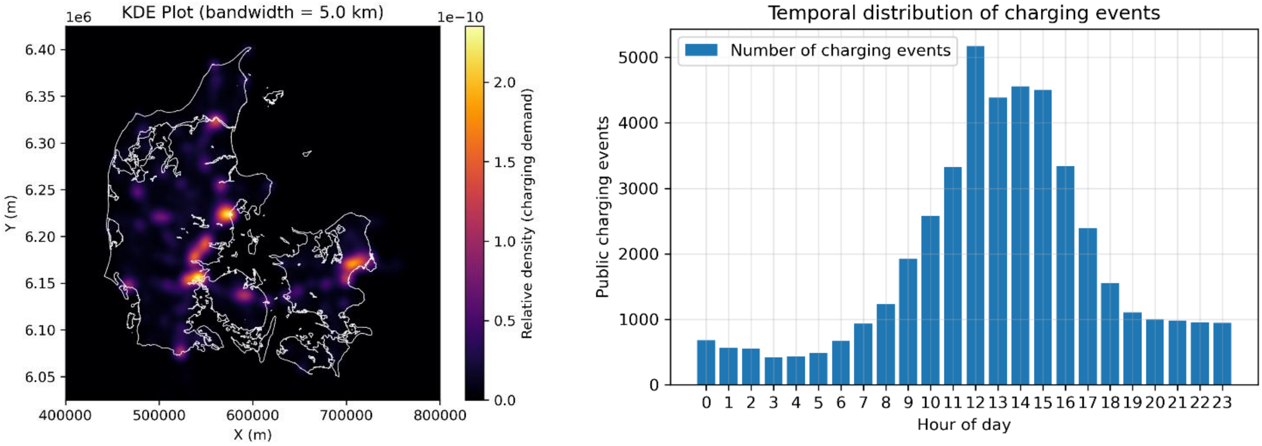

Figure 2: Spatial and temporal distribution of charging demand

In particular, the optimization favors areas in northwestern Denmark as important locations for new charging stations. The results illustrate a trade-off between serving high-demand areas and improving geographic coverage, where limited existing coverage is favored over high-density regions in proximity to existing charging infrastructure.

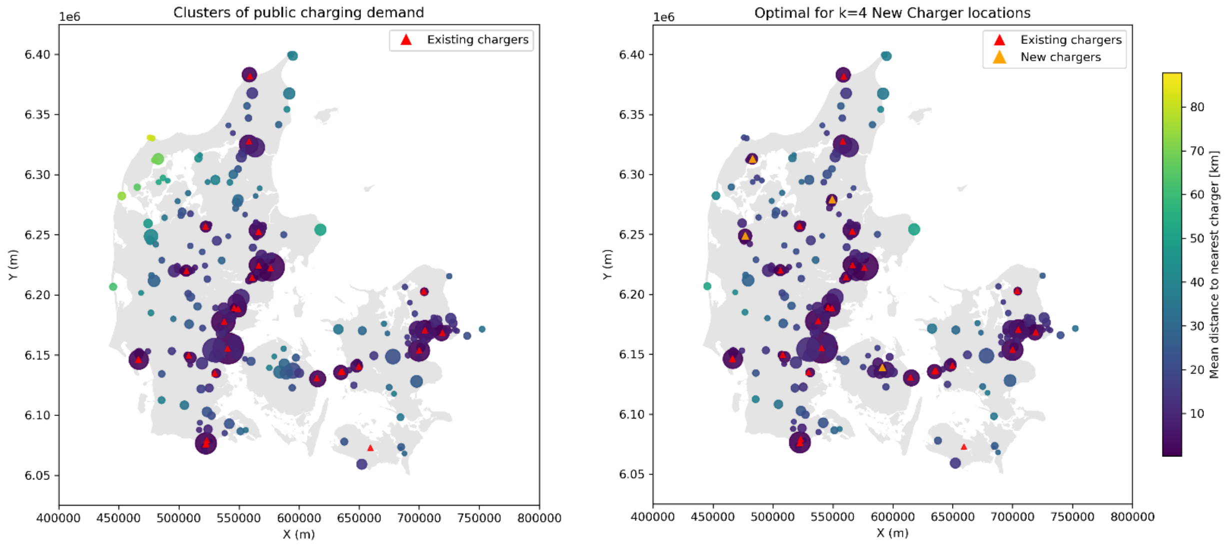

Figure 2: Clustering result and proposed new location when using 4 new locations

Discussion

The simulation of charging demand is based on simplified assumptions regarding vehicle range and charging behavior. The results should therefore be interpreted as an indicative representation of potential charging demand rather than a precise forecast.

Despite these limitations, the results show patterns, with charging demand concentrated in both space and time. The analysis highlights a areas limited existing coverage, In particular northwestern Denmark

An important limitation is that the model does not account for proximity to existing charging infrastructure in route planning, as charging demand is assumed to arise near trip endpoints.