Fluent cycling in the city? Measuring urban cycling quality with tracking data

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How fluent cycling is in your city? Are you able to cycle without unnecessary stops or do you need to stop all the time? The ProGIS awarded master thesis introduces a procedure for estimating cycling fluency in urban areas.

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As one of the most environmentally friendly modes of travel, cycling plays an important role in designing sustainable urban mobility. In an ideal, cycling-friendly city, the infrastructure should allow cyclists to travel fluently. They could cycle continuously so fast as they want, undisturbed by other road users and without having to stop and wait.

More and more cyclists use the sport tracking applications to record, monitor and share their rides. So more and more large-scaling data is collected by mobile application providers. As a result, the spatio-temporal extent and number of data contributors is unprecedented.

This all has made extensive data-driven analysis of urban cycling possible. We will now have a better understanding of the status quo and we are able to take effective measures to make cycling in the city more convenient and attractive.

Calculating fluency index for street segments

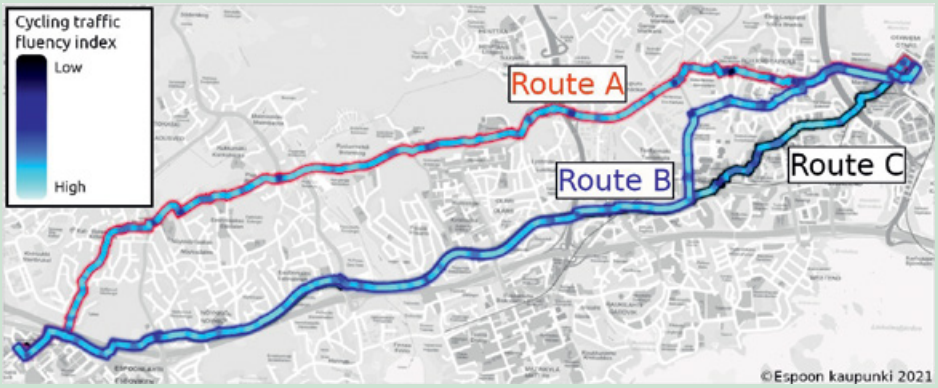
My master thesis introduces a procedure for estimating urban cycling fluency using mobile tracking data. The study is based on more than 50 000 real-life tracks on ”Sports Tracker” mobile application. The tracks were recorded by almost 3 700 cyclists in Helsinki area between years 2010 and 2012. All the tracks were publicly available in the application.

First, we make a pre-processing to the data. All the tracks are smoothed and cleared from outliers. After that they are mapped to the street network and divided into small segments. Each segment was about 25 meters long. For each segment a track passed, we calculated properties related to the cyclist’s dynamics and stopping behavior.

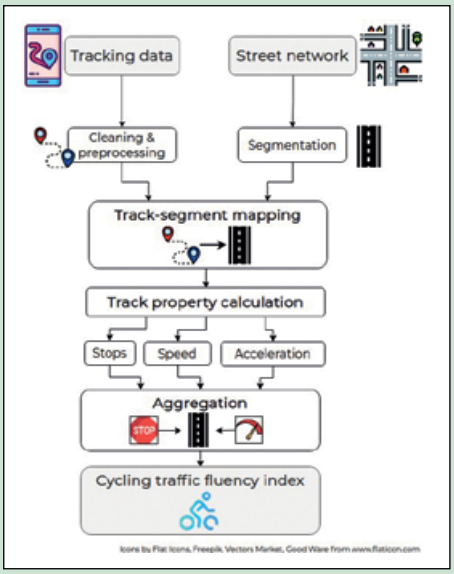
If a segment is passed by at least ten different cyclists, these cyclists’ properties are aggregated into segment characteristics. These four characteristics describe different aspects of cycling fluency. The characteristics are:

1) How many of the cyclists stopped on the segment?
2) What was the average duration of these stops?
3) How high was the cyclists’ acceleration on average?
4) How fast the cyclists ride on this segment compared to their average travelling speed?

Based on these four characteristics



Fluency of three different cycling routes between Otaniemi and Kivenlahti in Espoo. Route C is the shortest and Route A the fastest according to the dataset, but Route B offers the most fluent cycling experience.



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Overview of the procedure: tracking data is processed along with street network data to obtain an estimate of cycling fluency.

we calculate the final cycling fluency measure. Each segment will obtain an index between 0 and 1. Higher the value more fluent the cycling is on that segment. The speed is relatively high and accelerates a little. There are no frequent stops or long waiting times. The lower index values, on the other hand, indicate obstructions on the segment.

A promising estimation from imperfect data

After we experimented the results with the different secondary data, it became clear that the results describe the on-street circumstances in and around Helsinki sufficiently well. The cyclists' stops correlated clearly with the locations of traffic lights and intersections. Cyclists' movements correlated the properties of a single track on the certain segment.

This suggests that the aggregated values can predict, at least to some extent, how fluently an individual cyclist is able to cycle on the segment.

However, the data can only show us, what was the situation then, not what the situation is now. Additionally, we don't know how many of the stops were deliberate. Maybe the cyclist only wanted to take a picture for example. They are difficult to detect and thus distort the results.

Also, the data does not give a whole picture of the cyclists in Helsinki. 10 % of cyclists made 65 % of tracks recorded into the Sports Tracker. And, of course, most of the cyclists in the dataset are very likely, the confident and enthusiastic cyclists.

Challenges, like no socio-demographic information about cyclists or participation inequality, are unavoidable, when we work with data recorded uncontrolled.

However, the challenges will get smaller after we get more data. The irregularities of individual tracks do not affect so much anymore in the cycling fluency index, when there are a few tens of cyclists or more on one segment.

A cyclist-centered perspective of the city

The procedure described here is one possibility to condense mobile activity tracking data into one indicator for urban cycling quality. It offers a unique cyclist-centered perspective on the accessibility of cycling in the city. It could also support the design and monitoring of urban cycling infrastructure.

We also experimented to use the cycling fluency index as a routing criterion. That experiment showed us that fluency-based routing gives us the route resembling the fastest route but suggests detours on the most popular cycling routes. Even though the index does not possess a notion popularity!

Thus, there is a potential for the measure to be utilized for developing advanced, data-driven routing algorithms for cyclists.

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Teksti julkaistaan poikkeuksellisesti englanniksi.