Cycling Analytics for Urban Environments: from vertical models to horizontal innovation

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Abstract. The full potential of ITS can only be achieved in a global scale and combining the efforts and the knowledge of multiple entities. This is also true for the current efforts towards the application of data, communications and services, to improve cycling and its integration into general mobility systems. The currently prevailing paradigm is based on disperse and self-contained custom processes, which fail to promote distributed and open innovation. These models are hard to reproduce, generalize, recombine or improve outside the context in which they were originally implemented. A digital platform strategy might offer a viable and scalable way to support convergence between multiple models and promote their usage as shared references for cycling ecosystems. In this work, we aim to validate our assumptions about the limitations of current development paradigms and analyse the extent to which a platform strategy could offer a fundamentally different approach to address those limitations. To validate the problem and uncover generalisation opportunities, we study 3 cycling mobility models and make an initial analysis of how the general principles of digital platforms could be applied as a general framework for a new type of solution for cycling analytics. The results confirm a high potential for horizontal features and outline a set of key design principles for the development of a digital platform strategy for cycling analytics. This should constitute a major contribution to inform the development of a new generation of cycling platforms for urban environments.

Keywords: Cycling Analytics; Mobility Models; Horizontal Innovation; Urban Cycling; Smart Cycling; ITS for Smart Cities: Sustainable Transportation; New trends in ITS

1 Introduction

Cycling, and micro-mobility in general, are increasingly central in urban mobility policies [1]. This change is being driven by a combination of environmental [2], sustainability [3], public health [4], life quality [5] and economic agendas [6, 7], but also by market trends towards urban, shared, electric and connected bicycles. In this context, the vision of Smart Cycling has been emerging as the shared, real-time, and collaborative application of data, communications and services, to help best move people individually, and collectively, across the urban environment [8]. This domain of Intelligent Transport Systems (ITS) can be particularly vital for tackling Europe's growing emissions and congestion problems. ITS can make cycling mobility safer, more efficient, and more integrated into general mobility policies through the systematic integration of information and communication technologies. Moreover, these technologies should enable new cycling related services with the capability to promote diverse forms of data-driven Innovation, help cyclists with relevant ride information, empower citizens to co-create and inform local mobility policies and allow urban planners to make more informed decisions about cycling infrastructures

While cycling data is still sparse, recent years have seen considerable interest in the application of mobility models to cycling or even in the development of new models addressing specific cycling needs. Many mobility models have been proposed to represent particular dimensions of the cycling reality of a city or region. These mobility models include compound indexes to assess bikeability [9–11] or bike-friendliness [12–14], custom tools to estimate the potential for cycling [15, 16] or the economic value of cycling [17] and a few commercial services based mostly on data from mobile applications [18]. There is also a very broad range of smaller and more focused models, serving specific perspectives of analysis, such as hilliness [19], pollution [20], route choice [21], comfort [22] or accessibility [23]. These models are often published as open-source projects and, overall, they represent a wide spectrum of analysis of the many dimensions of urban cycling.

However, the full potential of ITS as a transformational force for urban cycling still seems to be unfulfilled. Many of its building blocks may already be there, but they are not connected in ways that allow them to deliver the type of shared, real-time collaborative application of data envisioned by smart cycling. There are many relevant models, but in the end, only a small community of users with strong technical knowledge on how to prepare, process and explore this type of data is able to work with them. This is slowing down the uptake of relevant research results by the market. Common citizens, and even the people that are meant to manage cycling mobility, may not have the expertise, the time or the practices to get value from those models. This is a particularly relevant problem for municipalities and urban planners who miss accurate, comprehensive and actionable data about the cycling reality of their city.

In this work, we hypothesise that the root cause for this problem might be the prevailing development paradigm, mostly based on disperse and self-contained custom processes, which fail to offer the necessary context for distributed and open innovation. Developing a mobility model normally involves a single entity that starts from a concrete dataset, applies specific algorithms, produces new data structures, and creates tailored visualizations to represent the new insights. This type of vertical self-contained process is very flexible because there is no need to consider generalization or integration issues, but it leads to monolithic models. Even when source code is shared, it often lacks the level of generalization needed to make it a clear option for other similar cases. Also, even if the model is essentially the same, the diversity of implementations or even just small variations in their assumptions can lead to fragmentation and a reduce capability to build on previous work. As a consequence, each new model becomes a self-contained package of data, specialised expertise, methodological practices, and conclusions that are hard to reproduce, generalize, recombine or improve outside the context of the process in which they were originally implemented.

A digital platform strategy might offer a viable and scalable way to deliver the value of rich mobility analytics to urban cycling ecosystems. Digital platforms are a well-known strategy to optimize the innovation efforts of an ecosystem through combinatorial and distributed innovation across organizational boundaries [24]. They have a unique capability to harness new sources of innovation based on the principles of convergence [24] and generativity [26]. Convergence means that digital technologies can combine what were previously separate components or services. These new convergence spaces enabled by digital technology provide numerous innovation opportunities for products and services, potentially transforming a hugely fragmented space of data sources, mobility models and KPIs into a shared and actionable set of data references for cycling ecosystems. Generativity means that digital technologies can produce unprompted change driven by large, varied, and uncoordinated audiences [25]. They are never complete, as they are inherently dynamic and malleable, continuously evolving and being extended by the actions of users or the contributions of a large community of products and service creators. From the perspective of their communities, digital platforms offer them the possibility to innovate by customizing parts of the digital platform to serve their specific needs.

A platform strategy may also offer the type of continuous service, possibly available for multiple territories and ready to be used, that is needed for real impact. Most models are just conceived as conceptual tools or as a part of specific planning studies. They do not offer any type of service. The few cases that offer a systematic approach to the production of specific metrics, e.g. Propensity to Cycle Tool [26] or the Bike Friendly Index (www.bikefriendlyindex.com) [14], are focused only on a very specific set of metrics. A properly designed digital platform should be able to provide a systematic, collaborative, and incremental micro-mobility model development paradigm with the capability to support the convergence between multiple models and promote their usage as shared references for cycling ecosystems.

1.1 Objectives

In this work, we aim to validate our basic assumptions about the limitations of current development paradigms for cycling mobility models and analyse the extent to which a platform strategy could be able to offer a fundamentally different approach to address those limitations. As an initial step towards these goals, we conceived a study, mostly based on the analysis of current mobility model implementations, to address the following objectives:

- O1: Validate the prevailing existence of generic functionality across some of those models and characterise the corresponding opportunity for horizontal services that could facilitate their development and convergence

- O2: Make an initial analysis of how a digital platform strategy could provide a more promising approach to address the problem and bring many of those models into a common system with added-value for different cycling stakeholders.

2 Related Work

Researchers, urban planners and decision makers are seeking for new ways to understand cycling and make better decisions on how to promote the adoption of cycling.

Bikeability is a relatively recent concept, derived from walkability, that tries to describe how a city environment contributes to the adoption of cycling [27]. It is related to terms like bike-friendliness [11], bike-attractiveness [28], and bike accessibility [29]. Lowry et al. defined bikeability as the comfort and convenience of a bikeway network for accessing important destinations, and bike-friendliness as a combination of bikeability, laws, policies, and community education [30].

Bikeability and bike-friendliness are composite indexes created from a weighted aggregation of multiple other factors, which can themselves be generated through their own specific models, such as hilliness [10, 19], availability of bikeway infrastructures [31], the number of bikeway lanes or its width and typology [32], the network connectivity [28, 33], the road traffic [34] and the surrounding environment [10, 27, 35]. Some considered data obtained from open data sources, such as Gaode [31] or OpenStreetMaps [35], others from sensing and mobile applications [11], [39], while others use data obtained from surveys [32].

The Bike Score® index [38] is available for 130 cities across United States, Canada, and Australia. It comprises four equally weighted components, evaluating bike lanes, hilliness, connectivity to destinations and bicycle mode share. Copenhagenize [12] is a biennial index based on 14 different parameters. Parameters are grouped into three main areas: streetscape parameters, culture parameters, and ambition parameters. The Bicycle Cities Index [39] evaluates 16 city indicators related to cycling. This index focuses on six main categories related to weather, percentage of bicycle usage, crime and safety, infrastructure, bike sharing and events. Bike Friendly Index [14] evaluates the city cycling ecosystem using 12 indicators grouped around 5 main areas: hilliness, built environment, infrastructure, politic commitment, and bicycles habits. These components are then weighted to calculate the general index. To ensure replicability, this index is based on open-source data such as Census, Copernicus OSM and BASE Portal.

These indexes are a powerful tool for understanding the cycling reality of a city, possibly acting as a guide for urban planners, designers, and regulators to focus their efforts and investments on the development of a bicycle-friendly transport environment [40]. However, they are complex to generate, especially because only a small part of the metrics involved can actually be generated automatically in a systematic way.

Platforms represent an alternative way to approach cycling analytics. PCT [26] is a web-based tool for estimating cycling potential and corresponding health and CO2 benefits down to the street level for England and Wales. Using 2011 Census data for commuting and cycle to school, they quantify desire lines and simulate different scenarios. Pedal Heat® [41] is a platform that helps cities to visualize cycling traffic. Users can install a mobile application that incentivizes them to ride a bicycle through virtual rewards. Information is then sent to the platform where it can be visualized. The visualization layers include the cycling infrastructure, a heat map of the most demanded street segments and cyclists flow in real-time. Bike Citizens Analytics [42] is a platform that offers (commercially) cycling analytics and navigation based on data collected by users using the Bike Citizens mobile application. Users are incentivized through challenges, rewards, and badges. Strava Metro [18] is another commercial service that offers analytics services based on data produced by users of the Strava mobile application.

3 Methodology

This work is part of a broader research effort aiming at conceptualizing and developing a new type of cycling analytics platform for urban environments. This broader research is based on the principles of Design Science Research (DSR)[43], with this specific part corresponding to what might be described as first two steps of a DSR process [44]: problem identification and motivation and definition of the objectives for a solution.

In regard to problem identification, our main aim is to study the basic premise behind the motivation for this work, which claims that current mobility models for micro-mobility are mostly based on self-contained custom processes, which do not consider generalization or integration issues, and that it should be possible and advantageous to approach them instead as compositions of shared horizontal services in the context of a common platform. This should provide an initial validation of the overall approach, but it should also help to gain a deeper understanding of the problem with its multiple opportunities and limitations.

To validate the existence of generic functionality across multiple models and identify concrete opportunities for convergence around shared services, we conducted an analysis of 3 commonly used cycling mobility models. The approach is to decompose those models into a set of atomic steps and analyse the existence of shared generic operations. A high-level of shared generic operations should indicate a high potential for the creation of horizontal services that could significantly lower the effort needed to develop those model implementations.

In regard to the definition of the objectives for a solution, we seek to make an initial analysis of how the properties of digital technology platforms may be able to provide a more promising path for addressing the problem. Our approach has been to analyse how the general principles of digital platforms could be applied as a general framework for a new type of solution for cycling analytics and combine that with the results of the models' analysis to obtain an initial perspective on the expected properties of a generic platform for cycling analytics.

4 Results

The first step in this study was the selection and analysis of 3 cycling mobility models. We selected a small number because the aim was not to consider the complete range of possibilities, but only to have a diverse sample to assess some of the common operations that compose the algorithms that create those models. To better accomplish these goals, we select 3 models that are relatively simple in their algorithms, but address common, and yet, very diverse data processing goals in the cycling domain. Table 1 enumerates the 3 models used as input for our study.

Table 1. Mobility models analysed in this study.

Model	Description
Hilliness [19]	This model takes a Digital Elevation Model and a set of Street Network Data and classifies network segments according to the respective cycling effort associated with street slope.
Accessibility [23]	This model takes an origin-destination matrix with travel costs and classifies city areas according to their accessibility. The cost of each connection can be diverse, considering, for example, travel time, distance, cost, slope, among others. This model can be useful, per example, to have an overview of how accessibly vary in the same region for different indicators.
Route Characterization [Own model]	This model takes a set of cycling tracks and a set of Street Network Data and classifies network segments according to properties extracted from those multiple tracks, e.g. average speeds, acceleration markers, stops, turns, and volume.

The following step was to analyse, in detail, the algorithms of each of these models and decompose them into a set of atomic code blocks. Each of those blocks should correspond to a sequence of related instructions aiming at a common action that would not make sense to execute partially, in this or in other contexts. We then analysed each of these atomic blocks to assess its potential for generalization or integration. Table 2 is a selection of the atomic code blocks, from the 3 models, which we identified as having the potential to be offered to many different models as common horizontal features in a digital platform. These algorithms are often created for a specific purpose and, even if they often include many library functions, they also have strong dependencies associated with the concrete assumptions of a particular implementation.

Table 2. Possible horizontal features identified in the analysis and their dependencies.

Operation	Analysis of possible dependencies
Get street network data from Open Street Map	This requires domain knowledge about the usage of the OSM API. There is an implicit spatial scope that makes this operation specific to the implementation. The output data itself can be generic.
Get shapefiles for region boundaries	This requires domain knowledge about the availability and integration of region boundaries. There is an implicit spatial scope

	that makes this operation specific to the implementation. The output data itself can be generic.
Annotate a route network with slope information	This requires domain knowledge on how to obtain and apply elevation data for a concrete region. There is an implicit spatial scope that makes this operation specific to the implementation. The output data itself can be generic.
Classify a route network according to a cycling effort model	This requires domain knowledge on classification models for cycling effort. There is an implicit spatial scope that makes this operation specific to the implementation. The output data itself can be generic.
Estimate impedance and accessibility from OD matrix and opportunities	This requires domain knowledge on classification models for cycling effort. There is an implicit spatial scope that makes this operation specific to the implementation.
Map matching route points to OSM points	This requires domain knowledge on map matching methods.
Compute average speed for road network segments.	Code can be reused with any compatible route data format, but only a service aggregating multiple routes is able to make these aggregate calculations.

The first observation is the high number of procedures that are not specific to each of the models and could potentially be approached as horizontal services, available as part of a digital platform, to serve similar needs across multiple cycling models. From the analysis of merely 3 models, we were able to identify 7 procedures executing operations that may be seen as something that other models may also need to execute in very similar ways. Even if we only have a small sample of models, we can acknowledge these results as strongly aligned with our initial hypothesis about the existence of generic functionality across many of these mobility models.

Table 2 also represents the diversity of dependencies that we found in the analysis of these 3 models, and which may prevent their reusage outside their initial implementation context. A very common dependency is the specific domain knowledge embedded across these implementations. This knowledge is often present in the usage of specific enabling services or data sources needed by those models, e.g. MapMatching, application of elevation data, mapping locations to administrative regions and their respective boundaries or working with Open Street Map. None of these is necessarily very complex, per se. However, having to learn about the correct usage of multiple services, all of which are just enablers for the concrete purpose of the model being developed, may represent a huge barrier to the development of new models or the usage of existing ones, even for users with general knowledge on mobility systems.

Another common form of dependency is related with the implicit scope assumptions, and particularly those referring to the spatial context of the work. For example, by focusing the model on a city, the selection of spatial data and the scope of the visualizations created can all be easily aligned. While some of these dependencies may be obvious from the implementation and potentially easy to change, many other are more deeply embedded in the code and severely limit the applicability of the same implementation to other spatial contexts.

There are also implications that can be linked directly to the self-contained nature of these models. An important group of operations involved the association with various type of geographic data, e.g. obtaining OSM road networks, obtaining elevation data to determine segment slope, mapping routes to OSM points or postal codes. These are not only very generic operations, they are also operations that could be done only once to serve the needs of many models. However, since each model is self-contained, it needs to independently obtain all of its data and repeat the process for each execution. In a platform approach, this type of global reference data could be managed as a horizontal feature to be shared by multiple models. Likewise, a shared service would also provide a much-needed aggregation context where data from multiple models could be treated in an integrated way and used to generate significant new value from the existing data. In particular, geospatial references are the ultimate convergence mechanism, allowing spatial relationships encoded in source data to support the aggregation of multiple independent data under a common spatial reference, and creating an immediate association between data that refers to the same region, postal code, route or route point.

There are also commonly used functions that operate on a specific dataset. Typical examples may include operations such as: convert between data representation formats, calculate metadata for a given route or the distance between two points in a route network. The existence of these functions saves model creators from additional programming effort, and promotes more robust solutions. While we can expect many of these operations to become part of a digital platform, this form of generalization is already supported by a multitude of code libraries available from multiple sources. Since their execution is self-contained process similar to a micro-service paradigm, they do not have external dependencies. Still, a coordinated library could play an important role in promoting convergence towards common approaches that improve the transparency of the models that use them and potentiate convergence towards common system approaches and data formats. It should also reduce the complexity involved in selecting and learning how to apply the functions from new libraries.

A final observation refers to the huge diversity of data types and formats that are involved in all of these models. Regardless of the obvious benefits that may emerge from more standard approaches to data publication, a cycling analytics platform should be designed to accommodate this extreme diversity, offering multiple convergence mechanisms to absorb that heterogeneity through various types of data transformations, rather than trying to impose its own data formats.

5 Key properties for a platform strategy for cycling analytics

In this section, we make an initial analysis of how a digital platform strategy could provide a more promising approach to address the challenges of urban cycling analytics. Considering that this is still largely an emerging domain, it may be too early yet to fully comprehend the nature of this new opportunity space and the concrete details of what these smart cycling ecosystems will look like. It will take some time, and many cumulative experiments, before we can reach a stage where a more grounded analysis of those properties will become possible. At this stage, we can build on the results of our study and also on the general principles of platform innovation [24] [26] to make an initial analysis of the key properties that may characterize a platform strategy to uncover the potential of digital innovation in urban cycling analytics.

Cycling specific. The platform should be focused specifically on the needs of micro-mobility. While obviously sharing many principles with more mature forms of mobility analysis, e.g. public transportation or automotive, cycling is nevertheless substantially different in regard to the nature of the data sources, the nature of route classifications, the key performance indicators or the role of real-time data. This focus on the specifics of micro-mobility means placing those core needs at the forefront of the analytics systems. Still, despite these specific needs, cycling should not be seen as an isolated reality and the platform should always consider its own integration with broader mobility systems, particularly in a MaaS perspective [45].

A multi-sided platform for the cycling ecosystem. A basic premise for any Digital Platform is the ability to congregate many users and very different types of stakeholders. Cycling communities should find in this platform the ideal environment for a broad range of collective activities that will significantly expand the cycling experience. However, this form of convergence should also bring together many other types of stakeholders, such as bike sharing operators, bike shops, city authorities, mobility authorities, bike-friendly businesses, citizens in general, public parking facilities, bike manufactures or digital cycling technology companies. By significantly lowering the barriers for interaction, a platform should help to blur the boundaries between these many separate domains and unlock new forms of value exchange that will benefit all the stakeholders involved.

A global service for many local contexts. The need for cycling services is a global need. Therefore, the proposed platform should offer a broad set of tools, services, data and algorithms to address the cycling challenges of any city in the world, regardless of its characteristics or its level of cycling readiness. Also, the scale associated with a global service is also essential for reaching the critical mass that is needed for the platform to be perceived by others as a catalyst for convergence. However, this global perspective should be counterbalanced by the need to connect to local cycling ecosystems, which constitute a major source for locativeness and generativity-based innovation. This may involve the promotion of local cycling promotion groups, access to detailed information about the local infrastructures and regulations, the opportunity to participate in the co-creation of local mobility policies or specific MaaS integrations.

Collective Intelligence. The platform should have the capability to observe and learn about cycling mobility in a way that supports optimizations and informs decision-making at multiple levels of the system. Under a smart cycling paradigm, the bike should no longer be a single isolated entity. Instead, it should become a vehicle that can sense and share data, that can interact with other vehicles on the road, that can learn from its environment and from the way it is used. This capability to observe reality, learn from the initiatives undertaken, and continually adjust its services to incrementally and measurably improve the overall performance of the system should result in safer, more efficient or more enjoyable rides. Moreover, the significant volumes of digital traces generated from those rides should become a huge driver for new innovations, many of which will not even have been anticipated by the platform creators. Rather than a centralized data collector, the system should explore forms of situated intelligence that begin directly on the bike, e.g. to characterise the riding context, detect near miss situations or even send accident notifications, and go all the way up to the broader understanding of urban mobility.

Horizontal innovation. A normal consequence of generativity is that innovation activities increasingly become horizontal as efficiencies are gained by applying the same innovation activities and knowledge across multiple products or platforms [24]. A platform should thus provide a horizontal technical foundation upon which many complementary products and services can easily be combined, each offering its own set of knowledge-intensive features. This should promote the emergence of products that are excellent at offering a particular function across a broad range of usage contexts. A digital platform should make it possible for these products to focus on their key value propositions, while relying on others to offer those features which otherwise would have to be developed specifically for that product. This should lower the barrier for new innovations, as they can more easily emerge from simpler new products or from the multiple recombination possibilities that can emerge from repurposing existing products across many usage contexts. The horizontal innovation involved would enable the expertise associated with data models to become readily available across domains and usage contexts. This would help to bring together what are now separate experiences and domains, such as Urban planning, Urban KPIs, Mobility models development, cycling activism and cycling itself. Finally, generativity innovation would mean that many more and more advanced models could quickly emerge from the concrete learning resulting from the wide availability and usage of those models.

Progressive decomposition and convergence. From the results of the study with mobility models, we can identify the need to promote convergence between many independently developed analytics models. This should go beyond the use of a shared set of horizontal services or libraries and lead to a mesh of multiple interconnected models that may depend on each other as different layers of data processing. Given the inherent diversity of mobility models and data source, any convergence strategy should be very minimalist, avoiding constraints on how those models are executed, on what programming language they are developed or on the types of input data they might use.

Regarding data, the platform may promote some convergence by facilitating the use of canonical data formats for representing the most common types of data. While totally optional, a few well-known data formats for common data types, promoted by an extensive collection of conversion and aggregation functions may offer a shared resource that makes data convergence simpler, whenever suitable.

Regarding the algorithms of the models, the convergence process should promote their decomposition into basic steps. Each model needs to be described in a way that formally defines the model generation process as dataflows, with specific data sources, data transformations, concrete parameterizations of the algorithms used and concrete and publishable outputs. This could then be used to promote the progressive mapping of some of those parts into horizontal features offered directly by the platform. The explicit description of the transformation processes would thus constitute a key enabler for convergence. Even a simple description process, when made in a coherent way for multiple dataflows, can help to blur differences between various processes and emphasize any existing similarities. This should be a fundamental first step to decouple some of those elements from specific processes and make them available as horizontal features readily available for composing new models.

This should have a major impact in the development of cycling mobility models, reducing the development effort and potentially improving their overall quality, as most of their code would now be based on mature services with greater development quality, better performance and simplified programming models. It should also make more explicit the overlap between different models. Very similar models can be described in different ways and using diverse terminology. While it may not be possible to define absolute boundaries between model concepts, this analytics platform may help to promote convergence towards recognizable model categories with similar goals and offering similar properties. This should facilitate comparative analysis that place side-by-side alternative ways to produce similar outputs and assess their relative performance. This progressive abstraction and decomposition should ultimately lead to a many-to-many relationship between data sources and models, with common data types being explored in multiple ways by many complementary models and some models supporting the ability to be generated from alternative sources, and in this way be able to adjust themselves to the data reality of different cycling ecosystems.

6 Conclusions

The full potential of ITS can only be achieved if deployed in a global scale and in a way that combines and promotes the convergence of the efforts and the knowledge of multiple entities. This is also true for the current efforts towards the shared, real-time, and collaborative application of data, communications and services, to make cycling mobility safer, more efficient, and more integrated into general mobility policies. The currently prevailing paradigm is based on disperse, vertical, self-contained and custom processes, which fail to offer the necessary context for distributed and open innovation. As a consequence, each new effort results in a new package of data, expertise and methodologies that are hard to reproduce, generalize, recombine or improve outside the context of the process in which they were originally produced.

We have shown that despite their current dispersion, commonly used cycling models are composed of basic processes with a high potential to be used as horizontal features in the context of a digital platform approach. This represents an initial validation of the problem and highlights an opportunity for a new type of solution based on platform strategy. We have also identified some of the dependencies that are often embedded in the implementation of those models and prevent them from being widely repurposed by people outside their initial development context. These are fundamental hints for understanding how they can be redesigned around horizontal features shared among multiple model implementations.

Building on those results, and also on the more general principles of digital innovation associated with digital platforms, we have also outlined a set of key design principles for the development of a digital platform strategy for cycling analytics. This should constitute a major contribution to inform the development of a new generation of cycling platforms for urban environments.

6.1 Future Work

We are currently working on an initial prototype of a digital technology platform that can deliver the knowledge from the micro-mobility models in ways that professional urban planners, policymakers and citizens can use to create solutions for their own specific micro-mobility problems. This should include data processing capabilities, an analytics database with aggregated data, an API for supporting the creation of public services and a web portal with ready to consume data and services. This platform will be a major output of this work, but also one of its most fundamental research tools. As a generative platform, the platform will also be continuously challenged and continuously evolving with the progressive integration of new models and also more data, particularly data obtained from cyclists. We expect it might serve a powerful collaborative tool for engaging with other researchers and experts, especially in the field of urban mobility, who will have the opportunity to deploy their own models and explore their own research or planning goals.

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