ZOBA

Demand Prediction and Optimization for New Mobility

Executive Summary

Zoba was founded to bring best in class demand forecasting and optimization to mobility operators looking to increase their utilization and efficiency of service.

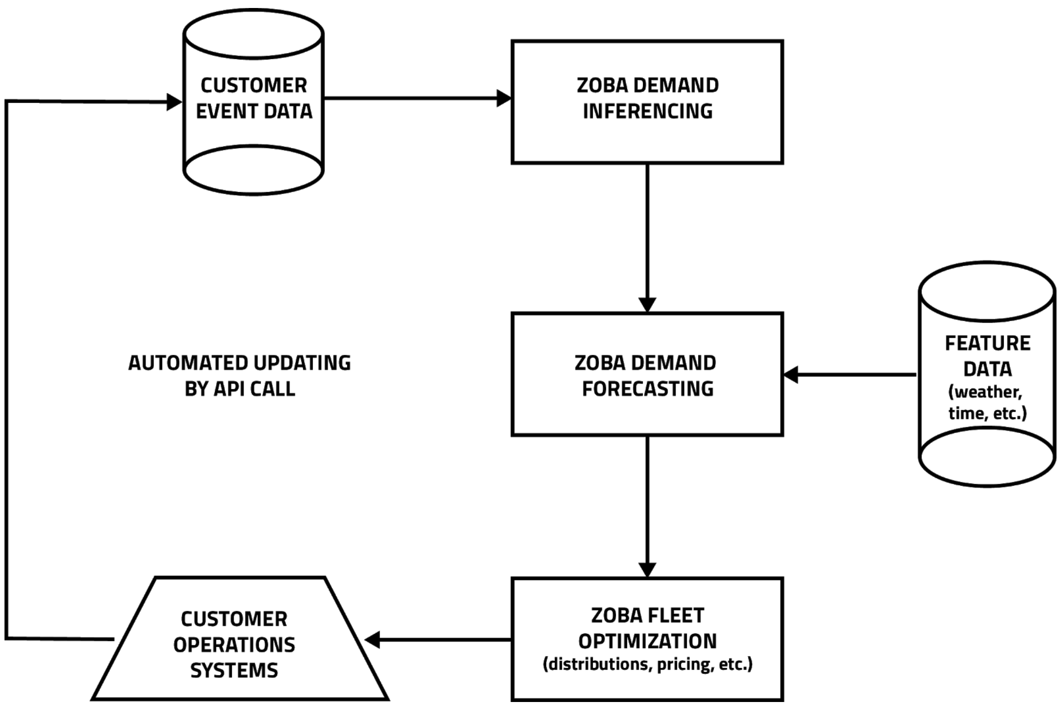
As new forms of on-demand mobility come to market, spatial analytics are becoming a key determinant of whether operators will be able to compete and succeed. To profitably deploy a shared mobility service, operators must continuously forecast demand and effectively optimize operational decisions—such as dynamic pricing or fleet placement—to service that demand. Until recently, the most potent technologies in the field were limited to a small number of university departments and market-leading ride hailing companies.

Zoba provides the most powerful suite of spatial data science and optimization tools available to on-demand mobility operators today. Working alongside internal teams, Zoba's forecasting and optimization services integrate directly into an organization's existing technology and operations stack to drastically improve performance.

Zoba currently offers solutions to both micromobility and car share operators (free floating and stationed based) around the globe. We will soon support solutions for service providers in ride hailing, on-demand delivery, last mile logistics, and autonomous vehicle services.

Product Overview

Zoba provides a suite of spatial forecasting and optimization modules via an API. These modules are selected and tuned to client-specific needs prior to deployment. Customer event data (e.g. ride start, end) is streamed to Zoba and fleet optimization results (e.g. vehicle distributions, price) are returned via API call. The system runs continuously in the background, learning from new data and changing real-world conditions.



Zoba's modules are roughly categorized into the following groupings: demand inferencing, demand forecasting, and fleet optimization. *Demand inferencing* is the process of estimating demand, which is unobservable, from ride events present in customer data. *Demand forecasting* relies on demand inferences and a host of Zoba-provided feature data about urban environments (e.g. weather, time) to predict where demand will be in the future. *Fleet optimization* leverages demand inferences and forecasts to provide actionable changes to a fleet. Each module is covered in more detail below.

Event Data Format

To use Zoba, companies provide vehicle-level historical event data (e.g. trip starts, trip ends) in an ongoing stream directly to the Zoba API (currently supporting CSV file format). These event data typically include location information (latitude and longitude coordinates) and time stamps. For example, Zoba uses the following event types to service micromobility fleets:

`ride_start`: when a user starts a ride
`ride_end`: when a user ends a ride
`maintenance_start`: when a vehicle is picked up for maintenance or rebalancing
`maintenance_end`: when a vehicle is dropped off after maintenance or rebalancing
`point_maintenance`: when a vehicle receives in-place maintenance

Events contain vehicle specific and include column fields: `datetime`, `vehicle_id`, `latitude`, `longitude`. Zoba typically receives data from customers in hourly intervals. Generally, Zoba can start to produce reliable results once a customer has at least 2-3 months of historical operational data in target markets.

Demand Inferencing

Before optimizing a fleet, Zoba must first model and then forecast latent demand. To do so, we must disambiguate observed *utilization*, or historical use of a service, from its inferred user *demand*. This distinction is subtle but vitally important.

- **Demand** is all the rides users would take in the absence of capacity constraints, i.e. the set of rides that would be performed if any user could get any vehicle at any place any time.
- **Utilization** is all the rides users *actually* take and is thus constrained by the available vehicles on which to take those rides.

If an area is saturated with vehicles, then the rides users actually take—the utilization—are an excellent proxy for demand. This rarely happens in practice. To try to understand true user intent despite this real-world supply constraint, Zoba applies proprietary demand inference models to a mobility service's historical ride data. True latent demand is not directly observable, so Zoba's demand models build on transportation theory to estimate demand from available historical data.

Zoba provides a variety of physically motivated models, each of which leverages a different aspect of the historical data. As a result, Zoba can estimate demand even in cases where only limited data is available, and if rich historical data is available, Zoba combines the individual demand models to form an improved demand estimate. Zoba's demand models transform historical data to construct proxies useful for inferring latent demand, including:

- **Idle Times:** spatio-temporal distribution of the amount of time vehicles sit idle between uses, controlling for the number of vehicles in each area;
- **Lead Times:** how far in advance vehicles are reserved, which correlates with user' first-choice preferences;
- **Spillover:** spatial spillover of demand in a city, which occurs as users with demand in one area accept vehicles in geographically adjacent areas.

While app-open and search data contain valuable information about demand, they are subject to large amounts of noise and are unreliable proxies for demand. Fundamentally, this is due to the low cost of searching: a user pays nothing but a few seconds of their time to search, and thus may perform searches which don't closely align with their true preferences. In contrast, actually using a vehicle is relatively expensive, and thus usage data provides reliable information about user preferences. When combined with our demand models, this usage data provides a reliable demand estimate. Therefore, we have thus far focused our efforts on the most reliable data—usage data—while continuing to investigate how app-open and search data can be leveraged to improve demand estimates.

Demand Forecasting

Once Zoba has estimated historical demand, we can use machine learning methods to correlate times and geographic areas of high demand with geospatially and temporally variable environmental data, like weather. Over time, Zoba's machine learning models learn from massive amounts of data how demand operates in different areas and conditions. We use those models to forecast demand conditions in new markets and types of environments. For example, Zoba can predict for a specific area of a city how future weather or other shifting conditions will impact demand.

In addition, Zoba can model demand for a new market—one in which a customer may have little or no historical data—by training a demand model in the customer's other markets and using transfer learning to deploy that model into the target city. Zoba's transfer learning models are generally trained across multiple existing markets to reduce the influence of market-specific factors in a generalizable demand model. Models are retrained as new data comes online.

Zoba maintains internal feature data sets used in machine learning models for demand forecasting. Our features include basic temporal features (e.g. time of day), open data sets—such as elevation and census data, and commercial data sets. Zoba's commercial feature datasets include sources related to high performance weather, events, population density, points of interest and more. Zoba regularly updates this internal data asset as new forms of feature data become commercially available.

Optimization

Zoba's demand estimates and forecasts are most valuable to a mobility service when they are being used to capture more demand in an integrated and ongoing way. We offer a variety of optimization models that leverage data-driven methods and mathematical optimization to optimally serve users' demand—whether *optimal* means maximizing rides, maximizing revenue, maximizing accessibility, or any combination thereof.

Zoba's optimization models are tailored to what the optimal outcome is for a specific mobility service. Our most popular optimization models are the following:

- **Vehicle Distributions:** our most popular optimization model returns the optimal distribution of vehicles to capture available demand.
- **Dynamic Pricing:** dynamically applies discounts or other pricing variance according to demand at a given time (e.g. discount lowest demand areas).
- **Fleet Sizing:** calculates optimal vehicle supply levels to service forecasted demand within a given service level.

All of Zoba's optimization models return values specific to the model and are adjustable to service customer needs. Further, each model returns data on the cadence tailored to the specific customer use case. For example, dynamic pricing may need to be queried every minute, while a vehicle distribution may only be used for the first vehicle placement of the day.

When using the *vehicle distribution* model to optimize for demand capture, the response from the API call contains the number of vehicles to deploy at each station and the estimated demand that will be captured at each station under this vehicle distribution. The estimated demand can be used to predict the fleet performance for a given day.

Integration and Deployment

Zoba's platform is, by design, modular and adaptable to the needs of individual fleet operators. Before deployment, Zoba spends approximately one month tuning its technology to specific company needs and constraints (e.g. vehicles required in specific areas, KPI to optimize). Typically, Zoba works closely with a customer's internal operations and technical stakeholders during the onboarding process. We see ourselves as force multipliers to an internal data science team and ask that they be directly involved in our process as company domain experts.

Once deployed, it is straightforward to scale Zoba from initial markets to coverage of all company fleets. After initial development Zoba's platform processes new data and serves optimization outputs seamlessly through direct integration.

Zoba's Value and Engagement Structure

The majority of mobility operators use Zoba with the goal of substantially increasing their fleets' utilization, often by more than 10%. That being said, optimizers can be deployed to maximize the KPI that best fits a service's priorities. Zoba works with new customers to create a custom offering of Zoba's modules that best fit the operational goals of the organization.

Zoba welcomes external testing and validation of its technology. We provide new customers with the opportunity to observe value through proof of concept (PoC) deployments. During a PoC phase, Zoba deploys models in a limited subset of company markets and carefully measures efficacy in improving performance. We do so by measuring the statistical impact of Zoba's deployment on a target metric, such as utilization, and controlling for other factors (e.g. seasonality).

Once a customer observes Zoba's impact on their PoC market, Zoba works with them to extend coverage to the rest of the company's fleets. Zoba charges monthly on a per asset basis to facilitate testing before scaling our service.

About Zoba

Zoba is a spatial machine learning and optimization company focused on demand forecasting for shared mobility systems. Zoba's platform enables mobility companies to granularly and dynamically forecast demand and optimize supply to meet it. By integrating Zoba's product into their workflow, clients see higher utilization and expedited adoption of their service.

Zoba was founded out of Harvard and MIT and is backed by leading investors including CRV, Founder Collective, Mark Cuban, and Aaron Schildkrout (Uber's former Head of Data).

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