*Wiz*RD: An Interactive Data Analysis Platform for Urban Environments

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***Index Terms*—Data Visualization - Analysis - Case Studies**

I. Introduction

*Wiz*RD is a flexible and extensible platform developed in the context of the MUSA project [1]. It is designed to support personalized and context-aware services in urban environments. The platform provides a set of capabilities that allow the integration of heterogeneous data sources and the development of applications that combine user preferences with contextual information, such as weather, traffic, and road conditions.

The platform architecture is modular and supports multiple functionalities, including user profiling, route simulation, and interactive data visualization. Thanks to this flexibility, *Wiz*RD can be used in different scenarios, both for user-oriented services and for urban planning support.

The first use case developed on top of the platform focused on personalized pedestrian navigation. The application suggested walking routes that consider not only the shortest or fastest path, but also individual preferences, such as safety, comfort, or accessibility.

In this article, we present a second use case, which highlights the platform's potential for urban planning. In particular, we show how the data visualization and analysis component of *Wiz*RD can be used to support decisions about the placement of infrastructures, such as bus stops or water fountains, and to identify effective locations for advertisement billboards based on target user groups.

The remainder of the paper describes the platform architecture and its core components, and discusses the design and implementation of this second use case.

II. The *Wiz*RD Platform

*Wiz*RD is a platform that integrates data processing, aggregation, and storage to support interactive applications capable of displaying the stored data and performing real-time calculations. Although it was initially developed as a supporting tool for a wayfinding application, the platform was designed from the outset with a flexible and modular architecture. This has allowed it to evolve into a general-purpose framework that can support various use cases, including data visualization and analysis.

The platform follows a traditional client-server architecture. The server component is implemented in Java using the Spring framework and uses PostgreSQL as a backing store. The database natively supports geospatial data through the PostGIS extension, providing operations such as intersection and combination of geospatial objects.

*Wiz*RD uses a portion of the freely available and crowdsourced OpenStreetMap dataset [2], [3] to build its road network representation, enriching it with data from various sources. The platform uses a robust preprocessing pipeline to process and homogenize input data. This pipeline has been designed to be adaptable to arbitrary data formats. Currently, it supports OSM dumps, tabular data in CSV format, and heatmaps in the form of 1-channel grayscale PNG images.

We developed a frontend using React.js and Leaflet.js, which serves as a demonstrational wayfinding platform for the MUSA project. The project aims to promote digital, inclusive, and sustainable urban ecosystems. In particular, the *Wiz*RD platform contributes to MUSA's objectives by supporting intelligent and accessible mobility in university districts.

While the original goal was to support personalized navigation, the frontend has been extended with a visualization component that enables interactive spatial data exploration. Users can apply filters and visualize various metrics, such as walkability, traffic, or pollution, supporting both route customization and more general analysis tasks. This visualization component is described in detail in the following section.

III. Data Visualization and Analysis Extensions

During development, we introduced several features that simplify data exploration, improve the visualization of the information stored in the dataset, and integrate heterogeneous data sources.

By leveraging these same capabilities, we then envisioned a different use case that involves *regulatory users* (e.g., urban planners or advertising companies) as the end users. For example, the platform could be used to analyze pedestrian behavior under varying conditions to decide where to place

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new bus stops or advertisement billboards to maximize their effectiveness.

A. Basic Operations

The data visualization and analysis component offers a comprehensive set of tools to help users create dashboards that can generate customized views of specific portions of the dataset. In particular, the visualization component offers users the following tools:

- **Source selector** allows users to choose which data source to visualize. It can display values from a single column or, as explained in section III-C, use more complex computed data.
- **Filter** allows users to limit the visualization to specific portions of the road network. For example, users can opt to visualize data related only to footways or cycle paths.
- **Visualization strategy** lets users configure how data is visually represented. It includes parameters for setting lower and upper bounds for the displayed data, selecting a color scale, and adjusting the width and transparency of the segments used for representation.

B. Advanced Visualization Options

The framework also supports layered data, meaning data points that vary over time or across conditions. These variations of the same data point are referred to as **profiles**. The source selector can identify whether a data point has multiple profiles and allows users to select which profile they want to use. Only one profile can be chosen for a specific data point at a time.

C. Custom Functions and Precomputed Metrics

To support more complex analyses, the platform allows users to define custom **functions** that combine values from different columns in a user-defined manner and compute new metrics in real-time. These functions are written in PostgreSQL and can be added during database creation or later through updates. For example, a function might generate a composite score combining traffic and pollution data. The source selector tool allows users to utilize a function as a data source.

If a function is particularly computationally intensive, **procedures** can be employed at the time of database creation to calculate aggregated metrics and cache the results directly in the database. The resulting column will be treated as a distinct data point.

IV. Use Case

To illustrate the capabilities of the *Wiz*RD platform in a real-world context, we present a use case involving urban planners for the Milano-Bicocca neighborhood in Milan.

These planners need to determine where to strengthen pedestrian road infrastructure (e.g., walkways, access ramps, safety equipment). They are aware that people often walk across the neighborhood due to the presence of university buildings and important landmarks such as a museum (Hangar Bicocca), a theater (Arcimboldi), and a shopping mall (Bicocca Village). As such, they decide to use the *Wiz*RD platform to analyze the behavior of pedestrians in the area.

A. Step 1 - Preparation

The urban planners create an instance of the *Wiz*RD platform that is limited to the Bicocca neighborhood and integrate their own data, including a walkability index (WI), traffic data, desirability, infrastructure quality, tree coverage data, and heatmaps highlighting the areas they are most interested in.

They also decide to precompute a variant of the safety index that takes into account the average traffic density along each road segment, using a procedure. In addition, they supply *Wiz*RD with functions that can be used to compute aggregations of various metrics on the fly.

The planners invoke the pipeline, and the database is populated with a processed OpenStreetMap dump and several columns describing the data points they have prepared and inserted.

B. Step 2 - Dashboard Setup and Initial View

The planners open the *Wiz*RD dashboard and are presented with an overview of the neighborhood. From the data visualization panel, they can select and visualize their metrics on the map. They can also use a function to compute a derived metric in real-time and visualize the results directly.

For example, they decide to display a computed indicator that combines their key areas of interest and highlights segments with high potential for pedestrian flow.

C. Step 3 - Exploration and Analysis

With the data infrastructure in place, the planners explore pedestrian behavior and identify high-priority areas for intervention. Using the interactive dashboard provided by the *Wiz*RD platform, they visualize aggregated metrics such as the walkability index, the infrastructure quality, and the safety index across the Bicocca neighborhood.

The planners use the platform's dynamic filters to isolate areas with high pedestrian traffic but low safety scores. They also use functions to compute and visualize an aggregated metric that includes desirability and tree coverage to understand whether the lack of pedestrian-friendly infrastructure occurs in otherwise attractive areas to foot traffic.

Next, they employ spatial querying features to select corridors between key landmarks (e.g., university buildings and the theater) and compute average walkability and traffic density values. They identify which connections most need improvement by comparing these values across different routes.

Ultimately, they run a custom aggregation function they previously defined to quantify intervention needs. This function outputs a composite priority score for each road segment, combining low walkability, poor infrastructure quality, and high pedestrian demand.

References

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