Landmark-Aware Heterogeneous Graph Framework for Multi Source Road Crash Data Integration in Nigeria

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Abstract

Proper forecasting of road crash in developing nations requires holistic, contextually relevant information that characterises complex spatial-temporal relationships. This paper presents a novel data collection and integration paradigm that was developed to address the most serious gaps in the studies on road safety in Nigeria. Using both Federal Road Safety Corps (FRSC) crash records and OpenStreetMap (OSM) geospatial data, a heterogeneous graph model of 559,622 road nodes and 81,986 amenity nodes in 37 administrative regions is built. The approach uses the Haversine-based proximity calculations and Gaussian radial basis functions to enrich the structure that provides a geocoding success rate of 93.7% and a 100.0% weather data enrichment in 104,672 crash records. The framework also builds landmark aware graph construction, where road infrastructure properties (type, speed limit, surface) are combined with contextual amenities (hospitals, schools, markets) by relation specific edges. Findings indicate high levels of completeness of data (95-100 percent core attributes) and effective implementation in a Neo4j graph system architecture. This paper provides a basis of

context-specific Graph Neural Network (GNN) models to match the local infrastructural and traffic peculiarities of developing countries, thus overcoming the constraints of Western-oriented datasets.

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