Chicago bike-sharing service operator provides user trips, bike routes, and historical station logs in three different datasets. The user trips dataset indicates bike transitions between two different stations in a form of tuples (trip id, timestamp, source station, and destinate station). The bike routes dataset represents a common path of the transitions in user trips, and the historical station logs dataset contains the number of available bikes and total docks in the stations. The user trips and historical station datasets compose the logs in every 1 hour and 10 minutes, respectively. The used datasets in our work are records for 22 days from December 10th to 31st. The user trips and station datasets are preprocessed into input sequences of bike transition maps and station status in time series, and the bike routes information is utilized as mete data that can improve the performance of a prediction model.

An event in our work refers to a state that requires bike rebalancing due to the over-demand of users or over-supply in bike-sharing stations. Our proposed model predicts the events at time and classifies states of the stations into over-demands, normal, or over-supply. The model has three layers that consist of input, prediction, and output layers. The input layer processes 168 hours of the station and trip data to compute them in the prediction layer and the output layer generates prediction results by referring to the bike route and time . The input layer of the model utilizes convolutional neural networks to capture spatial features from the transition maps and fully connected neural networks to extract temporal features from the historical station logs. These features in each time-step are converted into a tensor-vector through 2 fully connected neural networks. The prediction layer consists of 3 stacked and widths of long short-term memory cells to compute the vectors and results in a 512-dimensional vector. The output layer takes the one-hot vector format of time through a fully connected layer and concatenates its result with the 512-dimensional vector. The dimension of the concatenated vector is reshaped into the number of stations through 2 fully connected neural networks. The function activates the reshaped vectors to de-normalize prediction results into the number of bikes in the stations. The static condition method categorizes the results of the output layer into over-demands, normal, or over-supply, where the under and upper boundaries are set as 5% and 95%, respectively.