

Building Energy Efficient Traffic Congestion Prediction System

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Introduction

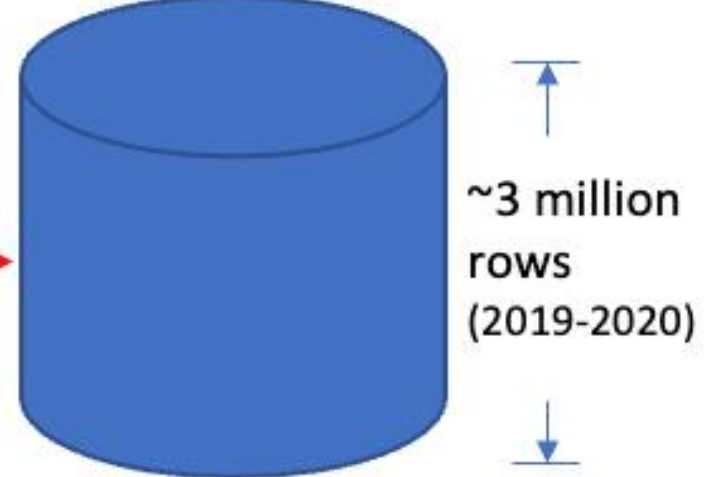
1. Traffic Congestion Prediction Systems (TCPS) are crucial to
 1. Achieve Sustainable Developmental Goals (SDGs)
 2. Reduce loss of life
 3. Improve health
 4. Faster travel travel
 5. Reduce pollution
 6. Reduce transportation costs
2. Several machine learning and deep learning models have been described for predicting traffic congestion on a road network.
3. Unfortunately, their approach of predicting the congestion on every road segment independently is not efficient for large-scale networks.
4. We aim to develop a sustainable and energy-efficient TCPS for large-scale transportation networks containing 100s to 1000s of road segments.

Challenges

1. How to handle big data containing millions of transactions?



(a) Road sensor network of Fukushima

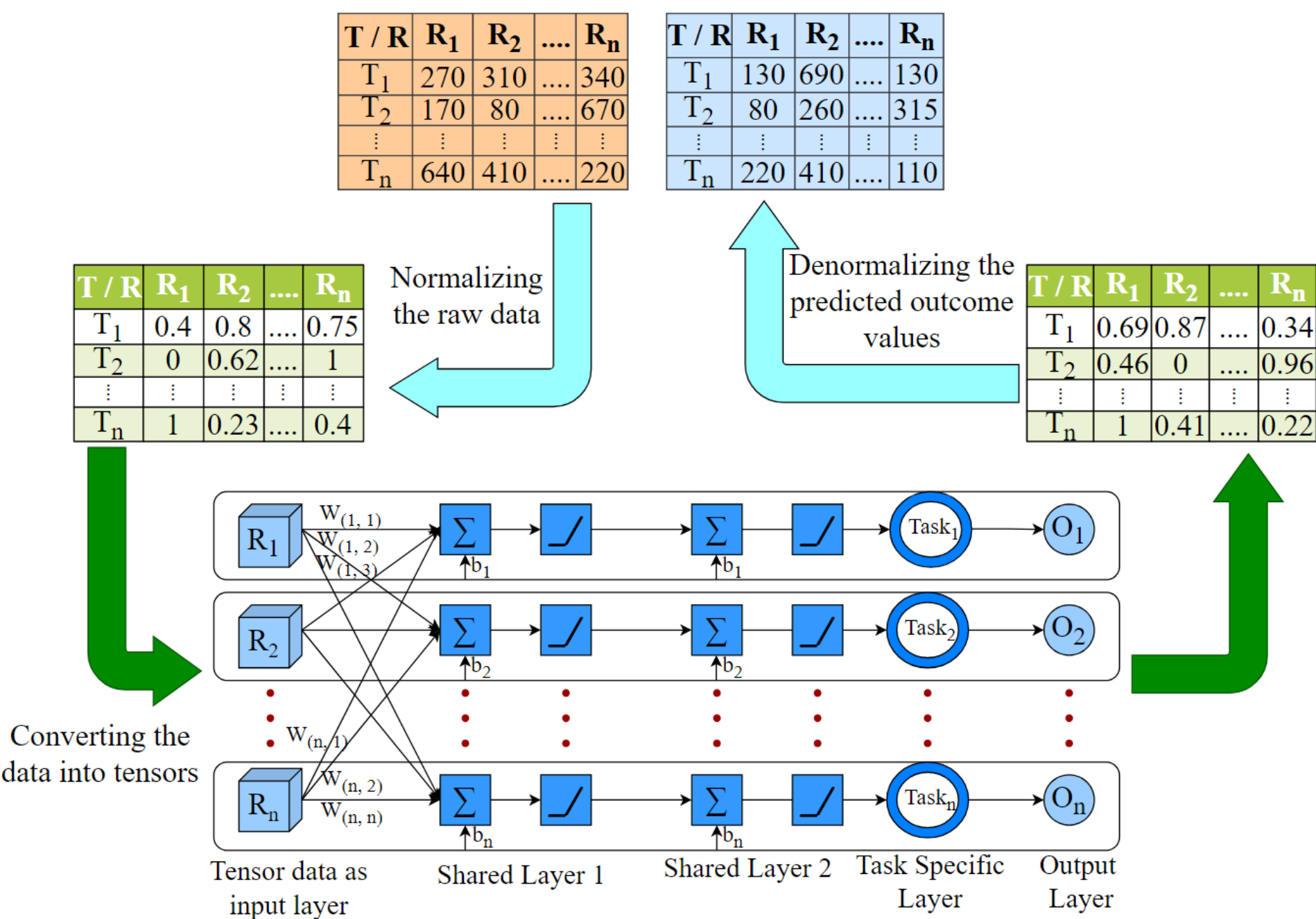


(b) 5 min. interval traffic congestion data

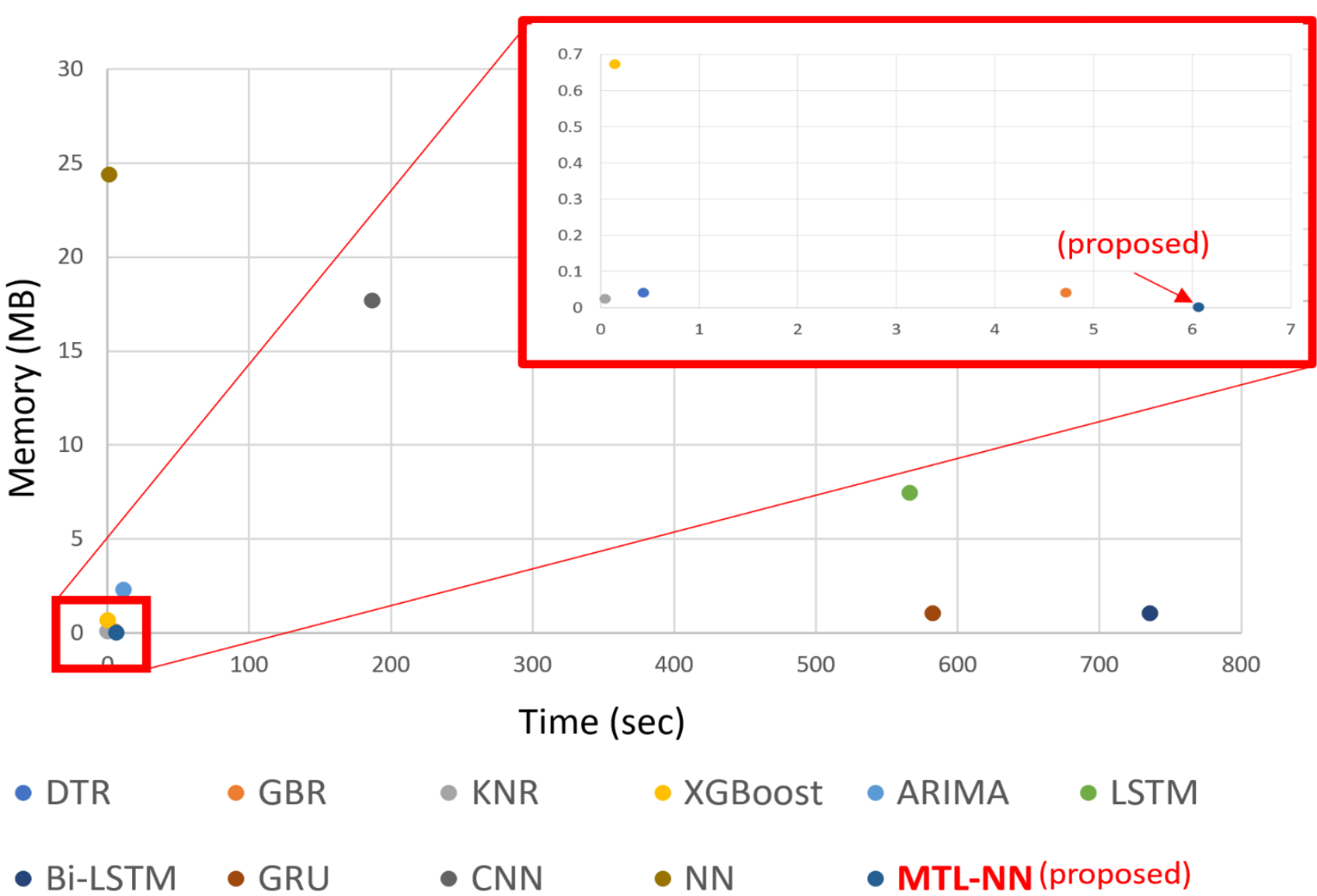
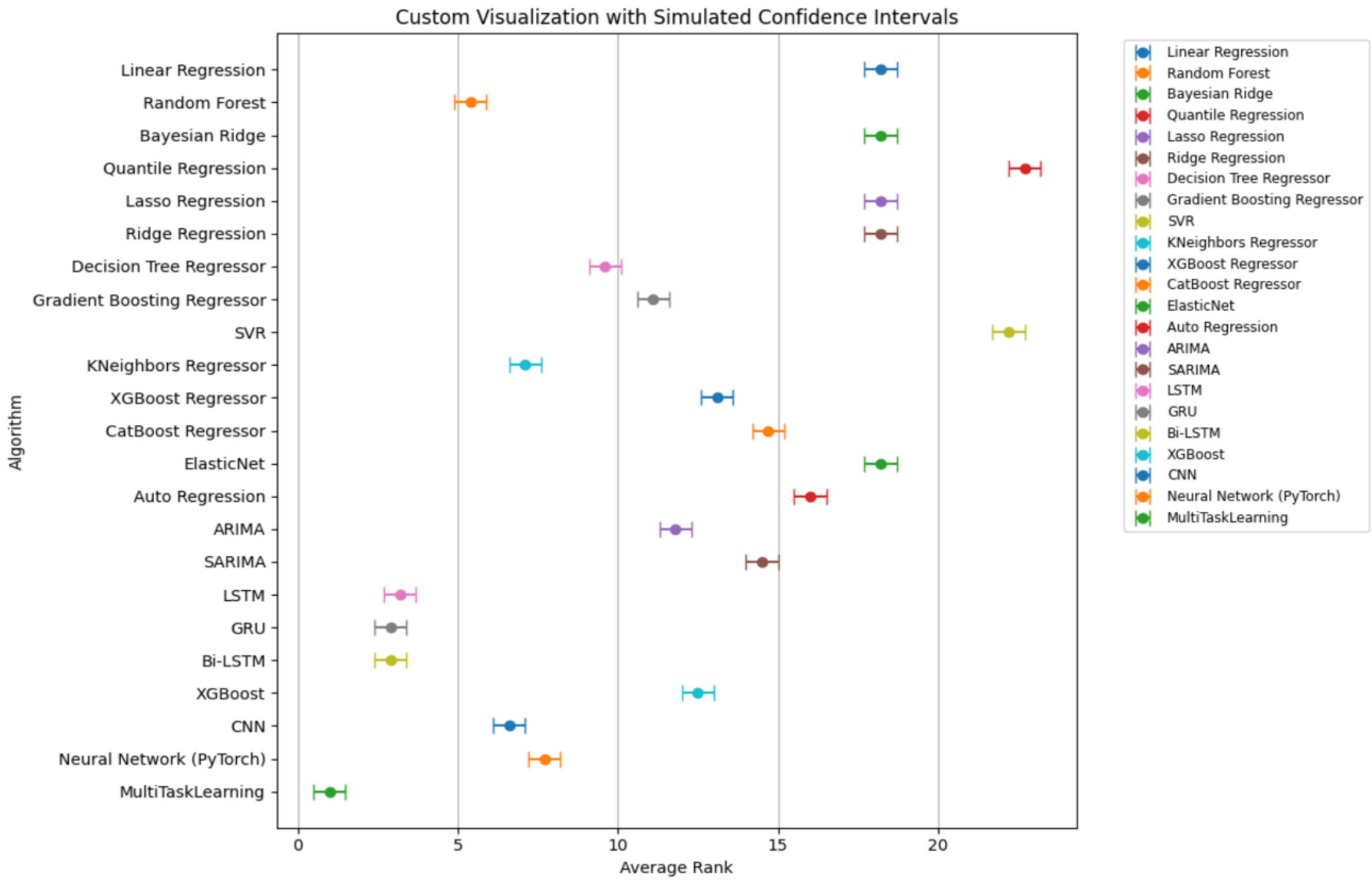
~3 million rows (2019-2020)
2. Open problem:
 1. Several models exist to predict traffic congestion
 2. Each model has its own selection bias
 3. Selecting a right prediction model is an open-research problem.
 4. Our research aims to address this open-research problem by evaluating various existing prediction models

Proposed Architecture

- Step 1: Preprocess the raw data into normalized data using Min-Max Normalization.
- Step 2: Convert the normalized data into Tensors
- Step 3: Input the tensor data into MTL-NN where input layers accept tensors as input.
- Step 4: The proposed MTL-NN model contains two hidden shared layers and a task-specific layer as shown in architecture. $A_i = \max(0, H_i)$
- Step 5: The hidden layers utilize linear transformation and ReLU activation functions. In the task-specific layer, based on the outputs from the hidden layers, the predictions are generated for each specific task. $H_i = W_i(\widehat{TR}_j) + b_i$
- Step 6: The training loop contains the following sequence steps in the architecture
- Forward Pass $OR_j = W_{R_j} \cdot ReLU(W_2 \cdot ReLU(W_1 \cdot \widehat{TR}_j + b_1) + b_2) + b_{R_j}$
 - Loss Computation $Loss = \sum_{i=1}^N MSE(O_i, Y_i)$
 - Backward Pass $O_{T_k} = W_{T_k} A_F + b_{T_k}$
 - Parameter Update $\theta = \theta - \eta \nabla_{\theta} Loss$
- Step 7: Evaluate the performance of the MTL-NN model using the evaluation metrics
- Step 8 : Perform denormalization to obtain the actual predicted traffic congestion length values



Experimental Results



We identified MTL-NN as best model which is ranked as 1st in all models using a method named as Critical Difference Architecture

Publication details

Title: A Novel Multi-Task Learning Framework for Predicting Traffic Congestion **Authors:** Charan Teja MARRIMANU and Arjun Chakravarthi POGAKU
To be appeared at The 12th International Conference on Big Data and Artificial Intelligence (BDA 2024) with a 16% acceptance ratio