Outcomes / Results

Evaluation of models

<table>
<thead>
<tr>
<th>Model Type</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random forest</td>
<td>99.7%</td>
</tr>
<tr>
<td>Multiclass classification model</td>
<td></td>
</tr>
<tr>
<td>1: Random forest</td>
<td>60.3%</td>
</tr>
<tr>
<td>2: XGBoost</td>
<td>58.9%</td>
</tr>
<tr>
<td>3: Multilayer perceptron NN</td>
<td>50%</td>
</tr>
</tbody>
</table>

- Main design → important predictor variable in identifying bridge decks.
- Contributing predictor variable in determining the deck condition rating:
  - Age or the number of years since the last major reconstruction
  - Climate variables
  - Average daily traffic (ADT)
- NBI and traffic (FHWA)
- Spatially locating bridges
- Climate → PRISM
- Hazard → USGS
- 28 Independent variables: 19 NBI and traffic, 7 climate, and 2 hazard.

Approach / Methodology

- Big Bridge Data (BBD) development (Liu and El-Gohary 2016):
  - NBI and traffic → FHWA
  - Spatially locating bridges
  - Climate → PRISM
  - Hazard → USGS
- 28 Independent variables: 19 NBI and traffic, 7 climate, and 2 hazard.
- Machine learning models:
  - Has a deck or not → Binary classification → Random Forest
  - Predict deck condition rating → Multiclass classification
    - Random forest
    - XGBoost
    - Multilayer perceptron neural network (NN)
- National Bridge Inventory (NBI) to FHWA
- Bridge lengths > 20 ft visually inspected → $2.7$ billion
- Developing machine learning models:
  - Historical bridge data
  - Environmental data

Conclusions and follow-up research

- Spatial data → information at different positions in one year
- Spatiotemporal data → information over the years (Zhu & Wang, 2021)

- 3Vs Characteristics of BBD:
  - Volume: 30 times bigger than BBD of 2020
  - Velocity: one year updating speed
  - Variety: heterogeneous sources and different formats
- Five-year spatiotemporal BBD from 2016 to 2020 was collected:
  - Random forest multiclass classifier → 83.8% accuracy
  - Forecast the condition ratings of 2021 → $68\%$
- More research is needed:
  - Collecting spatiotemporal BBD of different years (available since 1992)
  - Develop ML models and evaluate their performances for forecasting of 2021 and 2022

Acknowledgements

This research was performed under an appointment to the U.S. Department of Homeland Security (DHS) Science & Technology (S&T) Directorate Office of University Programs Summer Research Team Program for Minority Serving Institutions, administered by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement between the U.S. Department of Energy (DOE) and DHS. ORISE is managed by ORAU under DOE contract number DE-SC0014664. All opinions expressed in this paper are the author’s and do not necessarily reflect the policies and views of DHS, DOE or ORAU/ORISE.

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