Deep Reinforcement Learning-based Project Prioritization for Rapid Post-Disaster Recovery of Transportation Infrastructure Systems

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Principal Investigator(s):

Yong-Cheol Lee

Louisiana State University

yclee@lsu.edu

Kunhee Choi

Texas A&M University

kchoi@tamu.edu

Lead Institution:

Louisiana State University

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Tran-SET

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Total Project Cost:

$150,000

Developing an integrated, data-driven organization for prioritizing post-disaster transportation reconstruction projects.

Of all the natural hazards that threaten transportation infrastructure, flooding and hurricanes represent a major hazard in Region 6 roadways as it challenges their design, operation, efficiency, and safety. These catastrophic natural disaster events generally lead to massive obstruction of traffic, direct damage to highway/bridge structures/pavement, and indirect damages to economic activities and regional communities which may cause loss of life. The recent large-scale floods such as 2017/2018 hurricanes and 2016 Baton Rouge devastating flooding reminded us how destructive hurricanes and floods are. The observed consequences from these events make evident their ability to generate largescale damages to society, raising the levels of exposure of all transportation infrastructure. For instance, Hurricane Katrina made landfall on August 29, 2005, providing some of the most plentiful and illustrative empirical evidence of the impact of hurricanes and storm surge on the performance of bridges and the transportation network. There is about 3,220 km (2,000 mi) of roadway in the Greater New Orleans area which were submerged in floodwaters for up to 5 weeks.

Problem Statement

After disasters strike, reconstruction and maintenance of damaged transportation infrastructure systems require each DOT to take costly long-term processes. In addition, planning and organizing post-disaster reconstruction and maintenance projects of transportation infrastructures are very challenging DOTs because they entail the substantial number of projects with various considerable factors and multi-objective issues including social, economic, political, and technical factors. Furthermore, decision-makers deal with limited federal, state, and local resources in planning sequential and organized reconstruction of affected transportation systems. Since transportation networks play a pivotal role in disaster recovery, the recovery processes should include short and long-term logistics and plan with underlying heterogeneous factors. Yet a comprehensive, integrated, data-driven approach for organizing and prioritizing post-disaster transportation reconstruction projects remains hidden. In addition, DOTs in Region 6 need to improve identifying and predicting the detailed factors and their impacts affecting post-disaster transportation recovery.

Objectives

The objective of the proposed research is to develop a data-driven reinforcement learning-based project prioritization system for rapid post-disaster reconstruction and recovery of damaged transportation infrastructure systems. This project also aims to help Louisiana and Texas (eventually all Region 6 States) in the systematic optimization and prioritization of the post-disaster reconstruction and maintenance plan of transportation infrastructure by focusing on social, economic, and technical aspects. To accomplish this goal, this project examines all roadways in Louisiana and Texas affected by previous flood disasters with the practitioners in the Louisiana Department of Transportation and Development (LaDOTD) as well as the Texas Department of Transportation (TxDOT). This project will first focus on two cities, Houma in Louisiana, and Houston in Texas. These areas will provide historical recovery and maintenance data of transportation infrastructure system. The data will be analyzed with the deep reinforcement learning technique which is a new feature integrating deep learning and reinforcement learning.

Intended Implementation of Research

Workforce Development: This project will provide an intuitive implementation guidebook for educating and assisting practitioners in DOTs in Region 6. This guidebook and its education materials will be used for workforce development

in post-disaster project prioritization and optimization of transportation systems including district engineers, planners, and decision-makers in Region 6's State transportation agencies.

Education: The proposers will work closely with each interest groups to show how these new technologies contribute to their needs and enhance post-disaster transportation recovery. Success in this research also promises significant impacts on engineering education. The findings and methods of this project are highly interrelated with the PIs' educational activities. The information will be integrated into existing and new courses at both LSU and TAMU.

Outreach: Articles, Journal publications, as well as presentations will be prepared. These presentations will be given at national conferences (like ASCE and TRB)

Anticipated Impacts/Benefits of Implementation

This study will produce the following deliverables: (1) a comprehensive project optimization system including data collection, fusion, and pre-processing, (2) a multi-agent model incorporating reinforcement learning as a state-of-the-art approach for developing an optimized reconstruction plan, (3) an interim and a final report including extensive documentation of the problem, proposed methodology, procedures and required data, and recommendations.

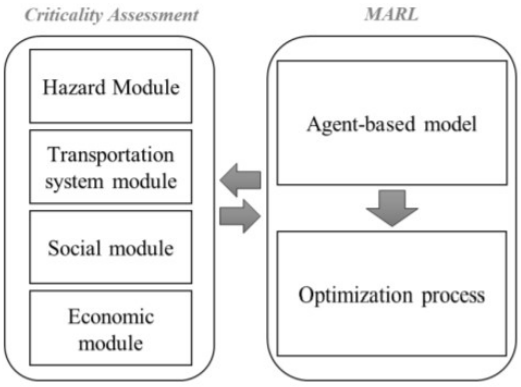

Figure 1: Structure of prioritization model

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.