Data Curation and Technology Transfer for Recent ERAU-CATM Projects

FINAL REPORT

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17. Abstract

The ERAU PI team has successfully conducted several CATM research projects over the last five years. Apart from generating several publications, these projects involved code development and data collection and generation efforts. To translate this research into practice and to generate self-sustained interest in these topics over the long run, we will pursue a two-pronged approach. First, we will release the codes in GitHub, which will allow other research groups to easily access and modify our codes. Second, we will increase the visibility of the projects by making researchers and practitioners aware of these projects and codes. Consequently, over the long term, this will lead to additional research contributions and practice.

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EXECUTIVE SUMMARY

The ERAU PI team has successfully conducted several CATM research projects over the last five years. Apart from generating several publications, these projects involved code development and data collection and generation efforts. To translate this research into practice and to generate self-sustained interest in these topics over the long run, we pursued a two-pronged approach. First, we released all codes under the MIT license in GitHub, which allows other research groups to easily access and modify our codes. Second, we will increase the visibility of the projects by making researchers and practitioners aware of these projects and codes through user satisfaction surveys. Consequently, over the long term, this is expected to lead to additional research contributions and practice.

DATA CURATION AND TECHNOLOGY TRANSFER FOR RECENT ERAU-CATM PROJECTS

The objective of this project is to facilitate the translation of CATM supported research over the past five years into practice. We will make different stakeholders including researchers and practitioners aware of our projects, and provide our software, data and case studies. We will evaluate the utility of the work through questionnaires and utilize the feedback to improve system design in future research.

The ERAU team has successfully conducted several CATM research projects over the last five years. Apart from generating several publications [1-12], these projects involved code development and data collection and generation efforts. To translate this research into practice and generate self-sustained interest in these topics over the long run, we pursued a two-pronged approach. First, we released the codes on GitHub, which allowed other research groups to easily access and modify our codes. Second, we increased the visibility of the projects by making researchers and practitioners (including non-expert practitioners) aware of these projects and codes through user surveys. To reduce the number of surveys, the codes and data corresponding to similar proposals was aggregated into three databases as shown in Table 1 below.

Table 1. CATM projects – Data and codes uploaded to Github

CATM Project Title	Software Developed	Data	Github Link
Particle Dynamics Model for Hurricane Evacuation and Fuel Shortage: Model Based Policy Analysis	Matlab codes for parameter estimation and predictive modeling of fuel shortages	Traffic data and Fuel shortage data during several hurricanes	Link
Multiscale Model for Hurricane Evacuation and Fuel Shortage			
Epidemiological Models for Transportation Applications: Secondary Crashes	Matlab and R codes for point-process estimation of probability that a given crash is a secondary crash	Crash data for several Florida highways	Link
Discrete Dynamics and Epidemiological Multi-Physics Models for Transportation Applications	Fortran and MPI codes for SIR infection modeling from pedestrian interaction data	Infection disease spread case studies	Link
Analyzing the Role of Air-Transportation in COVID-19 Pandemic Disaster.			
Multi-scale models for transportation systems under emergency	Fortran & MPI, Matlab codes for pedestrian movement modeling	Pedestrian dynamics case studies	
Multi-Agent Dynamic Reinforcement Learning-based Pedestrian Model for Emergency Evacuation			

Verification and validation are crucial for ensuring the robustness and increased use of the software. Verification requires mathematical accuracy of numerical solutions (such as the differential equation solver in social dynamics), while validation denotes the physical accuracy of the models [13]. Test cases were created for simple problems that could be solved or for which accurate numerical solutions were available, and an accuracy criterion was specified. Validation of the system, from the perspective of researchers in modeling, involved comparing it with empirical historical data. A set of known results, along with detailed specifications, is provided in our publications and along with the codes for comparison.

We solicited feedback on our software codes and case studies. We developed survey tools for three specific projects using IBM compute usability satisfaction questionnaires. We used CSUQ rather than the PSSUQ as the usability study is in a nonlaboratory setting. The questions for the survey are listed in Table 2. We have deployed the surveys and are in the process of collecting and analyzing the responses. We will utilize the usability survey results to improve the overall process and publish our findings regarding this process.

Table 2. Questions from the usability survey [14]

Q1	Did you find this explanation useful?
Q2	I am able to efficiently complete my work using this system.
Q3	I feel comfortable using this system.
Q4	It was easy to learn to use this system.
Q5	I believe I became productive quickly using this system.
Q6	The system gave error messages that clearly told me how to fix problems.
Q7	Whenever I made a mistake using the system, I recover easily and quickly.
Q8	The information (such as on-line help, on-screen messages and other documentation) provided with this system is clear.
Q9	It is easy to find the information I needed.
Q10	The information provided for the system is easy to understand.
Q11	The information is effective in helping me complete the tasks and scenarios.
Q12	The organization of information on the system screens is clear.
Q13	Please provide any comments you have on the VIPRA DSL

The specific projects, their abstracts, along with the links to the Github repositories and Qualtrics surveys are listed below.

Analyzing the Role of Air Transportation in COVID 19 Pandemic Disaster

GitHub Link

Survey link https://erau.qualtrics.com/jfe/form/SV_9ZHFXE5AcS4alRc

Despite commercial airlines mandating masks, there have been multiple documented events of COVID-19 superspreading on flights. Conventional models do not adequately explain superspreading patterns on flights, with infection spread wider than expected from proximity based on passenger seating. An important reason for this is that models typically do not consider the movement of passengers during the flight, boarding, or deplaning. Understanding the risks for each of these aspects could provide insight into effective mitigation measures.

Multiscale Model for Hurricane Evacuation and Fuel Shortage

GitHub Link

Survey link https://erau.qualtrics.com/jfe/form/SV_5uwMEazlLo3AibA

High-volume evacuations, disruptions to the supply chain, and fuel hoarding from non-evacuees have led to localized fuel shortages lasting several days during recent hurricanes. While news reports mention fuel shortages in past hurricanes, the crowdsource platform Gasbuddy has quantified the fuel shortages in the recent hurricanes. The analysis of this fuel shortage data suggested fuel shortages exhibited characteristics of an epidemic. Here, a Susceptible- Infected-Recovered (SIR) epidemic model is developed to study the evolution of fuel shortage during a hurricane evacuation. Additionally, we apply optimal control theory to identify an effective intervention strategy. The study found a linear correlation between traffic demand during the evacuation of Hurricane Irma and the resulting fuel shortage data. This correlation is used in conjunction with the Statewide Regional Evacuation Study Program (SRESP) surveys to estimate the evacuation traffic and fuel shortages for potential hurricanes affecting south Florida. Results indicate that evacuation of Miami-Dade County in the event of a

Category-3 hurricane landfall in the region, could lead to fuel shortages in up to 90% of the local refueling stations. The model indicates that this reduces to 28% by providing relief to 75% of the gas stations during the first two days of the evacuation.

Identification of Secondary Crashes using Temporal Point Process Model

GitHub Link

Survey Link https://erau.qualtrics.com/jfe/form/SV_88p3V1ZHoYLt9C6

Secondary crashes or crashes that occur in the wake of a preceding or primary crash are among the most critical incidents occurring on highways, due to the exceptional danger they present to the first responders and victims of the primary crash. In this work, we developed a self-exciting temporal point process to analyze crash events data and classify it into primary and secondary crashes. Our model uses a self-exciting function to describe secondary crashes while primary crashes are modeled using a background rate function. We fit the model to crash incidents data from the Florida Department of Transportation, on Interstate-4 (I-4) highway for the years 2015-2017, to determine the model parameters. These are used to estimate the probability that a given crash is secondary crash and to find queue times. To represent the periodically varying traffic levels and crash incidents, we model the background rate, as a stationary function, a sinusoidal non-stationary function, and a piecewise non-stationary function. We show that the sinusoidal non-stationary background rate fits the traffic data better and replicates the daily and weekly peaks in crash events due to traffic rush hours. Secondary crashes are found to account for up to 15.09% of traffic incidents, depending on the city on the I-4 Highway.

CATM

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