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Collaborative Research: RAPID:
**Addressing Transit Accessibility and
Public Health Challenges due to COVID-19**

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in collaboration with **Nashville MTA** and
Chattanooga CARTA public transit agencies

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Project Motivation

- Affordable public transit services are the backbones of many communities, providing diverse groups of people with access to employment, education, and other public services

- COVID-19 has disrupted the operations of public transit agencies and created exigent challenges for them

Resource Challenges

- **Reduced vehicle capacities** due to social-distancing requirements

- **Reduced driver availability** due to isolation and quarantine requirements
  - reduced service (*e.g.*, weekend schedule on weekdays)

- Disinfection requirements

Data Challenges

- **Changing ridership patterns** (temporally, spatially, and demographically)
  - ridership data and prediction are needed for proactive allocation of resources

- **Fare-free operations** due to social-distancing requirements
  - fare-based ridership data is unavailable

Project Overview

Research Thrusts

Data Analytics

- **Data collection** from Nashville and Chattanooga, TN
  - based on Automated Passenger Counters and manual counting
- **Data analytics** of transit agencies
  - estimating ridership patterns
  - predicting ridership using machine learning models
- **Passenger guidance** application
  - suggestions on how to avoid crowded vehicles

Optimization

- **Proactive optimization** of fixed-route transit services
  - maximize transit accessibility while minimizing crowding
  - considering exigent requirements
- **On-demand prioritization and dispatch** for paratransit services
  - many passengers are elderly and at higher risk for severe illness

Computer Vision

- **Ridership estimation** based on on-board cameras and video analytics
- **Monitoring** compliance with social-distancing and facial-covering requirements
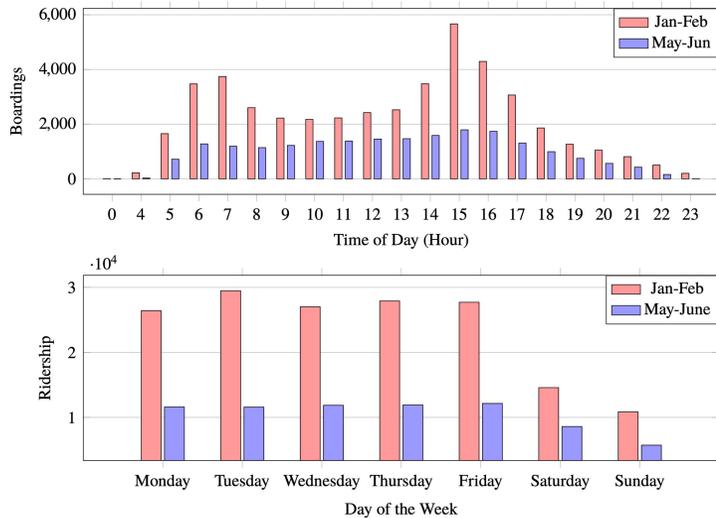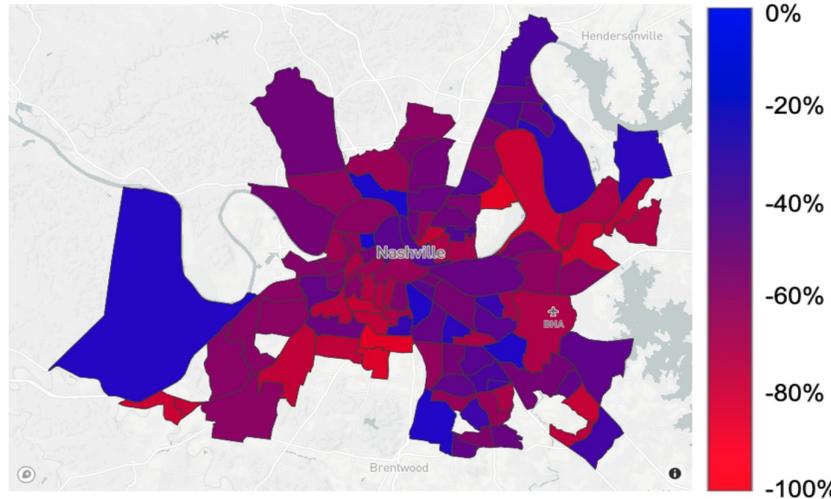
Data Analysis Results

- Most significant decrease in ridership on weekdays and during morning and afternoon commute hours

- Significant decrease in retail and shopping areas

- Decrease in transit ridership is more significant in high-income neighborhoods than in low-income ones

- Other significant factors include housing value and rent
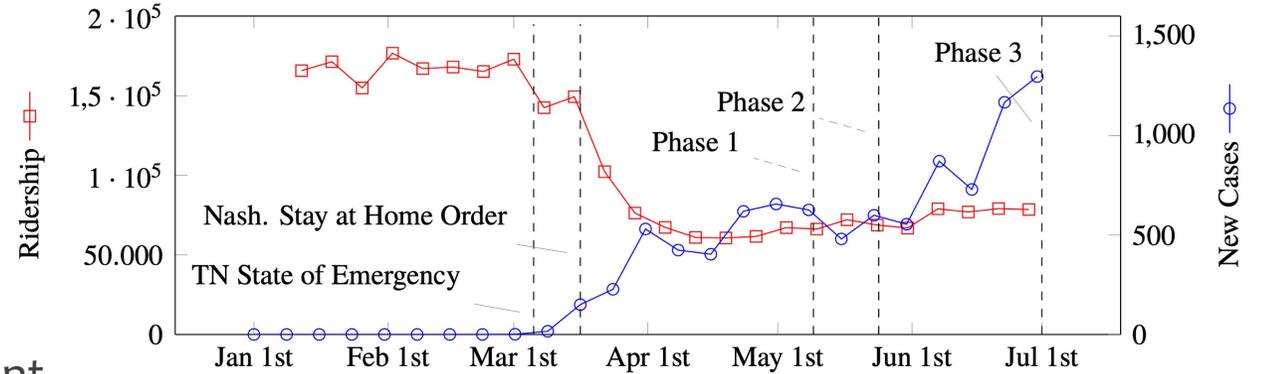
Temporal

Spatial

Socio-Economic

Metric	Pearson Correlation
Median housing value	0.35
Median income	0.21
Median rent	0.15
% African American	-0.02
% Hispanic	-0.19

Publication: Wilbur et al., "Impact of COVID-19 on Public Transit Accessibility and Ridership," 2021 Annual Meeting of the Transportation Research Board.

Work-in-Progress

Ridership prediction

- *goal:* estimating the likelihood of vehicle occupancy exceeding a threshold
- challenge: single predictor may not work well for the entire transit network due to variances between routes, stops, days of week, etc.
- we introduce a novel **neural architecture search** algorithm to design and train a number of predictors based on recurrent deep neural networks

Dynamic dispatch

- *goal:* continuously monitor vehicle occupancy and dynamically dispatch vehicles to ensure that capacity and service requirements are always met
- challenge: decisions must be made under uncertainty due to traffic, volatility of demand, …
- we introduce algorithms based on **Monte Carlo tree search** for dispatch optimization

Passenger detection

- we adapt state-of-the-art object detection algorithms, based on **deep convolutional neural networks,** to count passengers on-board
- we have found that the RCNN with Inception V2 architecture performs well; however, it needs further work

Thank You

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