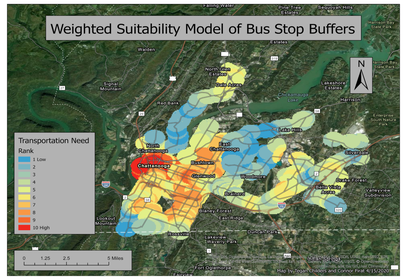
Mobility for All — Harnessing Emerging Transit Solutions for Underserved Communities

PIs and Researchers: Abhishek Dubey (Vanderbilt), Aron Laszka (University of Houston), Paul Speer (Vanderbilt), Chandra Ward (UTC), Mina Sartipi (UTC) , Philip Pugliese (CARTA), Dan Freudberg (WeGO), Samitha Samaranayake (Cornell), Siddhartha Banerjee (Cornell), Himanshu Neema (Vanderbilt), Ayan Mukhopadyay (Vanderbilt), Lillian Ratliff (UW)

Students and PostDocs: Jordan Jurinsky, Sayyed Vazirizade, Michael Wilbur, Amutheezan Sivagnanam, Afiya Ayman, Geoffrey Pettet, Juan Martinez, Daniel Gui, Ruixiao Sun

Understanding the Problem

- Transit agencies are trying to respond to the changing dynamics of ridership in their communities while managing the expectation of providing wide coverage.
- The problem has been exacerbated by the shifting patterns of ridership due to gentrification and changing demographics, leaving many communities underserved by transit.

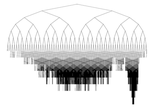


- Our solution is to develop a dynamic microtransit system that is integrated with fixed-line services and is managed considering (a) short-term demand forecast as well as (b) long-term expectations of the community.

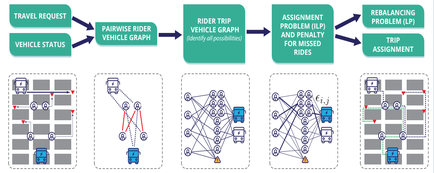
Decision-Theoretic Formulation

- We frame the real-time dispatch problem as an MDP.
- We design the objective to minimize the number of vehicles used and the total distance traversed by the vehicles (while satisfying demand).
- We introduce constraints based on pickup and drop-off times, operational information, capacity of vehicles, and passenger-specific needs.

Monte Carlo tree search: Game theoretic tree representation of process: Nodes ⟶ states, Edges ⟶ actions. The tree grows asymmetrically and uses fast (online) simulated playouts to estimate value of node



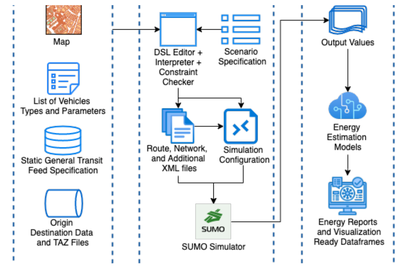
The tree is built by exploring various alternative using the DARP formulations.



- Our MDP state captures all relevant information about existing demands, passengers on board, future demand, and environmental uncertainty.

Performance Evaluation and Transit-Gym

- We are developing algorithms using active learning approaches to address three key problems:
  (a) hyperparameter selection,
  (b) model selection,
  and (c) performance evaluation.

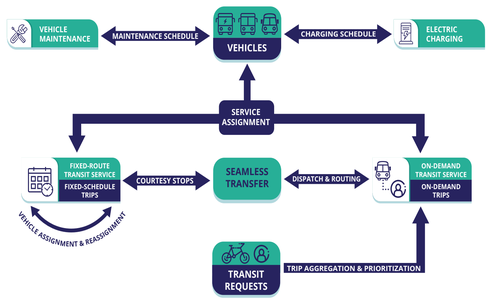


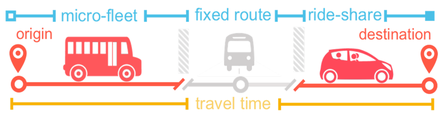
- A key aspect of the problem space is to combine the active learning algorithm with scenario specification to design simulation scenarios.

```
import "network.Chattanooga"
import "vehicle.BUS_type.xlsx"
import "gtfs.latest"
import "td.OD_person.od"

simulation configuration 1 {
        time [0000:1200]
        schedule weekday
        output_sampling_period 3600
        vehicleassignment {
                block 101:"Gillig_103"
        }
}

simulation configuration 2 {
        time [0000:1200]
```

Intellectual Merit

- We build on classical vehicle routing formulations to consider real-time requests and operational constraints.
- Our approach is decision-theoretic and inherently considers uncertainty in demand and environmental attributes like congestion and weather.
- We rely on a novel community engagement approach using the social relational approach pioneered in healthcare and election domains.

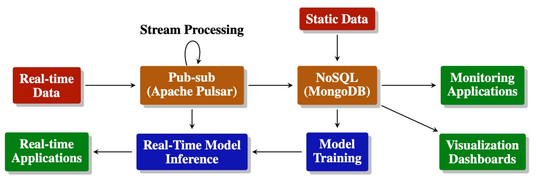




Data and Computation Architecture

- Use custom data architecture with parallel view and structures to optimize both graph-based and time-based queries.
- We are also investigating distributing outsourced computation to provide cheaper and sustainable alternative to cloud computing.
- The key challenges are privacy considerations and computation sustainability.

Data	Source	Frequency	Scope	Features	Schema/Format
Diesel vehicles	VinCiti and Clever Devices	1 Hz	50 vehicles	GPS, fuel-level, fuel rate, odometer, trip ID, driver ID	Viriciti SDK and Clever API
Electric vehicles	VinCiti and Clever Devices	1 Hz	3 vehicles	GPS, charging status, battery current, voltage, state of charge, odometer	Viriciti SDK and Clever API
Hybrid vehicles	Viriciti and Clever Devices	1 Hz	7 vehicles	GPS, fuel-level, fuel rate, odometer, trip ID, driver ID	Viriciti SDK and Clever API
Traffic	HERE and INRIX	1 Hz	Chattanooga and Nashville region	TMC ID, free-flow speed, current speed, jam factor, confidence	Traffic Message Channel (TMC)
Road network	OpenStreetMap	Static	Chattanooga and Nashville region	Road network map, network graph	OpenStreetMap (OSM)
Weather	DarkSky	0.1 Hz	Chattanooga and Nashville region	Temperature, wind speed, precipitation, humidity, visibility	Darksky API
Elevation	Tennessee GIC	Static	Chattanooga region	Location, elevation	GIS - Digital Elevation Models
Fixed-line transit schedules	CARTA, WeGO	Static	Chattanooga and Nashville region	Scheduled trips and trip times, routes, stops	General Transit Feed Specification (GTFS)
Video Feeds	CARTA	30 Frames/Second	All fixed-line vehicles	Video frames	Image
APC Ridership	CARTA , Wego	Every Stop	All fixed-line vehicles	Passenger boarding count per stop	Transit authority specific



Broader Impacts

- The project will have a potential impact across a wide range of cities in the U.S., which do not have well-developed transit systems as it will not only provide them with a reusable operations system, but it will also show how to develop a community program.
- The approach pioneered in this project is crucial to showing how to design smart city projects with lasting community integration. We believe that the social relational approach to engagement is critical for success.
- The project will also address privacy concerns arising in smart-city projects due to multi-modal datasets.

Community Engagement

- Social relationships are necessary for change.
- Citizens must come together collectively through formal organizations
- Organizations are successful to the degree that they develop relationships among members within a community.
- We are working to leverage existing social networks through key organizations in the city to continually inform, disseminate, validate, and evolve microtransit technology and applications.

Journal of Social and Political Psychology
jspp.psychopen.eu | 2195-3325

Special Thematic Section on "Rethinking Health and Social Justice Activism in Changing Times"

Re-Engaging Social Relationships and Collective Dimensions of Organizing to Revive Democratic Practice

Paul W. Speer*[a], Hahrie Han[b]

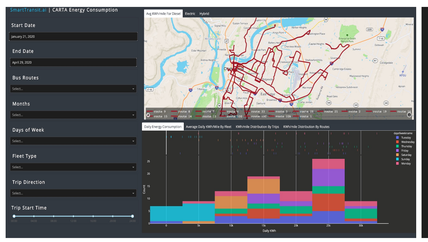
[a] Human & Organizational Development, Vanderbilt University, Nashville, TN, USA. [b] Political Science, University of California Santa Barbara, Santa Barbara, CA, USA.

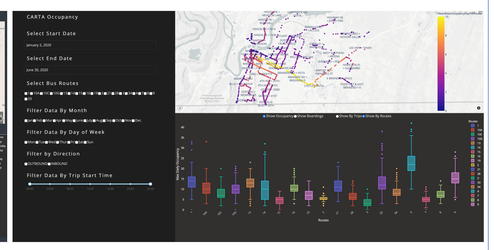
Abstract

The weakening of the everyday practice of democracy around the world presents profound challenges for social scientists working with an applied focus on issues of inequality and justice in social change. This paper examines community organizing (in the US) as an instrument for equitable and just social change, and argues that three interrelated trends are subtly undermining a core practice of organizing: developing social relationships. An expanding technocratic influence on politics, an inflated focus on individual-level metrics for evaluating organizing, and a growing belief that digital technologies and big data leverage greater power, combine to engender an atomized view of people, who are increasingly treated as consumers rather than producers of social change. In contrast, cultivating social relationships fuels the building of community and expanded networks that enables the exercise of social power necessary to effect change. Scholars promoting change for social justice should work to shape tools and measures to serve social dimensions of organizing and support people and collectivities as agents of democracy.

Keywords: community organizing, power, social justice, democracy, participation, collective action

Real-Time Performance Visualization and Analysis





System efficiency Occupancy and delay

We are building online applications to provide real-time status update of occupancy and route and efficiency of the system to public

Project Plan

Tasks (responsible investigators)	Year	2020				2021				2022				2023				2024		
	Quarter	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Area 1: Engagement (Chandra, Speer, Pugliese, Sartipi, CARTA community coordinator)	1.1: Community Engagement																					
	Focus Groups																					
	1.2: Capturing Needs and Understanding Barriers																					
	Community Workshops																					
	1.3: Sustaining Engagement via Transit Ambassadors																					
	Rider Surveys through CARTA																					
Area 2: Data (Laszka, Sartipi, Dubey)	2.1: Dynamic Management and Performance Assessment																					
	2.2: Privacy Extensions																					
Area 3: Optimization (Samaranayake, Dubey, Bannerjee)	3.1: Integrating Uncertainty and Behavioral Considerations																					
	3.2: Enabling Flexible Transit via Mechanism Design																					
	3.3: Service and Demand Flexibility																					
	3.4: Scalable and Sustainable Operations																					
	3.5: Integration with Fixed-Line Planning																					
Area 4: Active Learning (Ratliff, Laszka)	4.1: Hyperparameter Optimization																					
	4.2: Testing and Evaluating Microtransit Algorithms																					
	4.3: Online Model Estimation																					
Operations (Pugliese)	Phase 0 Engagement																					
	Phase I Deployment																					
	Phase I Assessment																					
	Phase II Deployment																					
	Phase II Assessment																					

2021 NSF S&CC Principal Investigators' Meeting
April 7-9, 2021

https://smarttransit.ai/

CNS: 1952011 (2020) IRG-1