Transit Information Utilization during an Extreme Weather Event: An Analysis of Smartphone App Data

Coline Remy Student [1] | **Dr. Candace Brakewood** Assistant Professor [2] | **Niloofar Ghahramani** PhD Candidate [3] | **Dr. Jonathan Peters** Professor [4] | **Eunjin Kwak** PhD Student [5]

[1] Ecole Nationale des Travaux Publics de l'Etat | [2] University of Tennessee | [3] City College of New York, City University of New York | [4] College of Staten Island, City University of New York | [5] Louisiana State University

Motivation and Background

Motivation

- Extreme weather events can severely disrupt urban transportation systems
- Difficult to study information use during extreme events with traditional data sources
- An alterative may be data that comes from smartphone applications

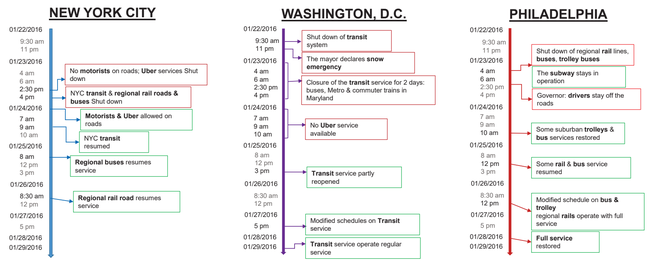
"Transit" Smartphone Application

- Free to download
- 125+ cities in 9 countries
- Android & iPhone
- Real-time transit and shared mobility information

https://transitapp.com/

"Winter Storm "Jonas"

- Hit the eastern United States from January 22-24, 2016
- 20 to 30 inches of snow
- Hourly timeline of public transit and Uber service (see figure)



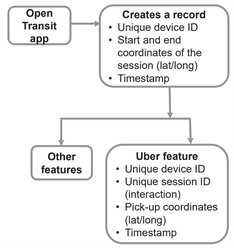
Research Question and Data Description

Research Question

- Can backend data from a transit smartphone app be used to study how travelers seek information during an extreme weather event?

Dataset

- Comma Separated Value (CSV) files obtained directly from "Transit" software developers, including:
  - ➢ All records of users' interactions with the app, regardless of the feature they check
  - ➢ All records of the users' interactions of the Uber feature



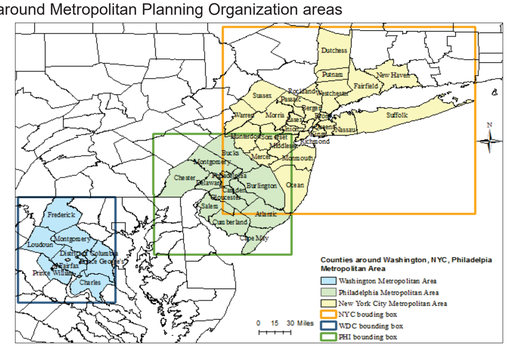
Time Period and Area of Analysis

Time Period

- Two weeks before & one week after the snowstorm (Friday Jan 8 to Friday Jan 29, 2016)

Area of Analysis

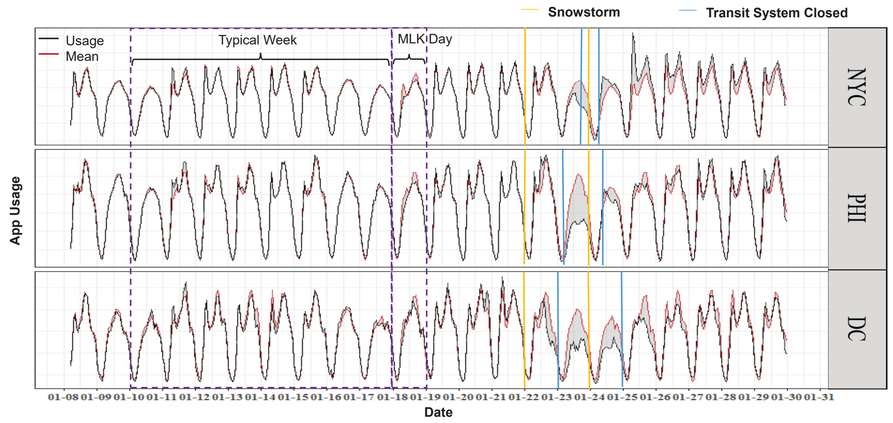
- New York City, Washington D.C. & Philadelphia
  - Large transit systems
  - Highly impacted by the storm
- Bounding box around Metropolitan Planning Organization areas



Methodology and Results

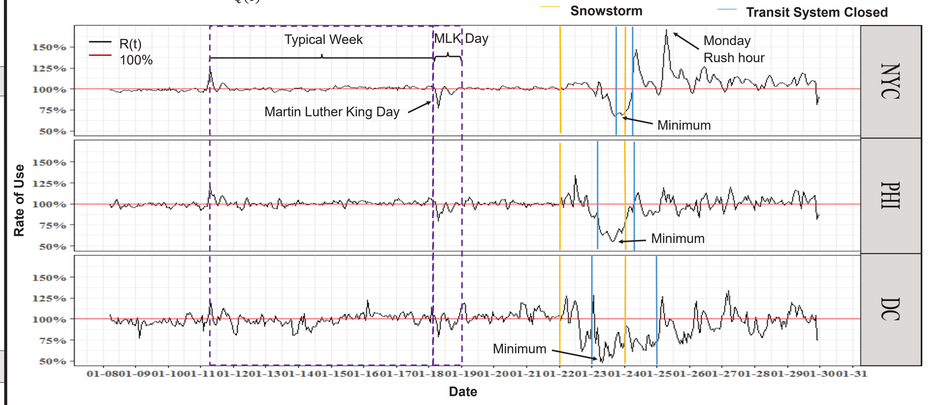
Part 1: Visualization of Hourly Transit App Usage

- Graph hourly total usage in each region compared to mean hourly usage during normal weather conditions
- Strong periodic weekly pattern during normal weather conditions was interrupted during the snowstorm



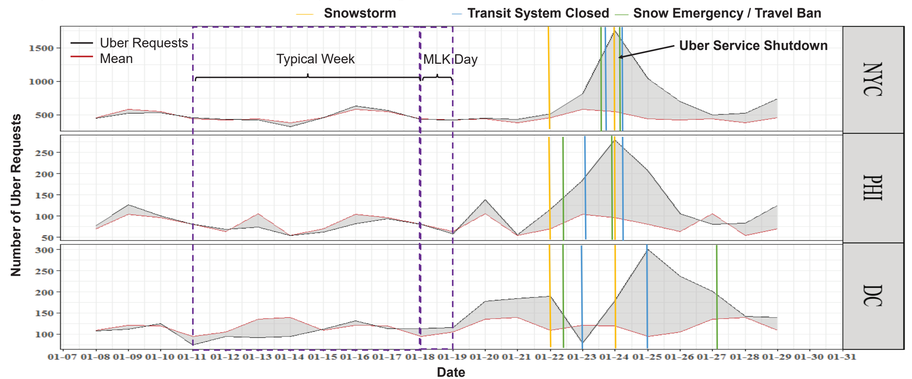
Part 2: Hourly Rate of Transit App Use

- Hourly rate of use: $R(t) = \frac{U(t)}{Q(t)}$ where *U(t)* is hourly app usage and *Q(t)* is mean hourly usage



Part 3: Visualization of Hourly Uber Requests

- Users could not book an Uber directly within the Transit app; instead, they are directed to Uber's app for fulfillment
- Despite travel bans, the number of Uber requests was greater than usual



Part 4: Regression Model of Transit App Use

- Ordinary Least Squares (OLS) regression
- Dependent variable: hourly number of Transit app records in each city
- Independent variables: Dummy variables for each day (Martin Luther King Day; 3 days of the snowstorm; 4 days after the snowstorm) and for each hour (167 hourly dummies)

	NYC	PHI	DC
Intercept	79,173.600***	8,568.542***	10,523.240***
	(2455.90)	(271.23)	(496.43)
Mon. Jan. 18 (Martin Luther King Day)	-3,843.750***	-576.625***	-547.333**
	(1,215.36)	(134.23)	(245.67)
Fri. Jan. 22 (1st day of snowstorm)	2,773.521***	381.437***	-528.813**
	(1052.53)	(116.24)	(212.75)
Sat. Jan. 23 (2nd day of snowstorm)	-8,925.937***	2,200.625***	-2,202.167***
	(1052.53)	(116.24)	(212.75)
Sun. Jan 24 (3rd day of snowstorm)	4,110.062***	-389.958***	-1,802.104***
	(1052.53)	(116.24)	(212.75)
Mon. Jan. 25 (1st day after snowstorm)	9,709.958***	-373.292***	-1,377.792***
	(1215.36)	(134.23)	(245.67)
Tues. Jan. 26 (2nd day after snowstorm)	7,013.187***	43.375	-525.708**
	(1052.53)	(116.24)	(212.75)
Wed. Jan. 27 (3rd day after snowstorm)	4,903.354***	250.750**	-48.19
	(1052.53)	(116.24)	(212.75)
Thurs. Jan. 28 (4th day after snowstorm)	3,544.271***	173.25	-411.500*
	(1052.53)	(116.24)	(212.75)
Observations	504	504	504
R^2	0.97	0.977	0.949
Adjusted R^2	0.955	0.965	0.922
Residual Std. Error (df = 328)	4,210.11	464.97	851.014
F Statistic (df = 175; 328)	61.650***	79.951***	35.105***

*Notes: *p<0.1; **p<0.05; ***p<0.01*
Standard error shown in parenthesis.
167 hourly dummy variables not presented in the table; available upon request.

Conclusions and Future Research

Conclusions

- Overall app usage decreased during the snowstorm in all three cities
- The number of Transit app searches during the snowstorm was surprisingly large, particularly during the period when the transit systems were completely shut down
- Transit app users continued to search for Uber service despite travel bans
- After the storm, New York City experienced a significant increase in overall app use during the first Monday commuting period; Washington, D.C. had the slowest recovery in app usage

Areas for Future Research

- Expand the analysis of Winter Storm Jonas to other regions, including areas that were not heavily impacted by the storm
- Examine Transit app usage patterns at the individual level, instead of at the metropolitan level
- Study other anomalous events, including both planned events such as concerts or sports events, and unplanned events such as hurricanes
- Compare utilization of the Transit app to other transportation-related smartphone apps

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Contact Information

- Coline Remy: coline.remy@entpe.fr
- Candace Brakewood: cbrakewo@utk.edu
- Niloofar Ghahramani: nghahra000@citymail.cuny.edu
- Jonathan Peters: Jonathan.Peters@csi.cuny.edu
- Eunjin Kwak: eunjinkwak0627@gmail.com