Analyzing Impacts of Major Events: A Case Study of the Los Angeles Memorial Coliseum

PSR Speaker Series
Feb 18, 2021

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The ADMS project

Research team

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Background

- **Problem**
  - Los Angeles traffic congestion
  - More than 2,500 special events held in Los Angeles every year adds to recurrent congestion
- **Objectives**
  - Measure special event effects on traffic
  - Devise strategies to effectively manage special event traffic
- **Case Study**
  - Weekend football games at the LA Memorial Coliseum

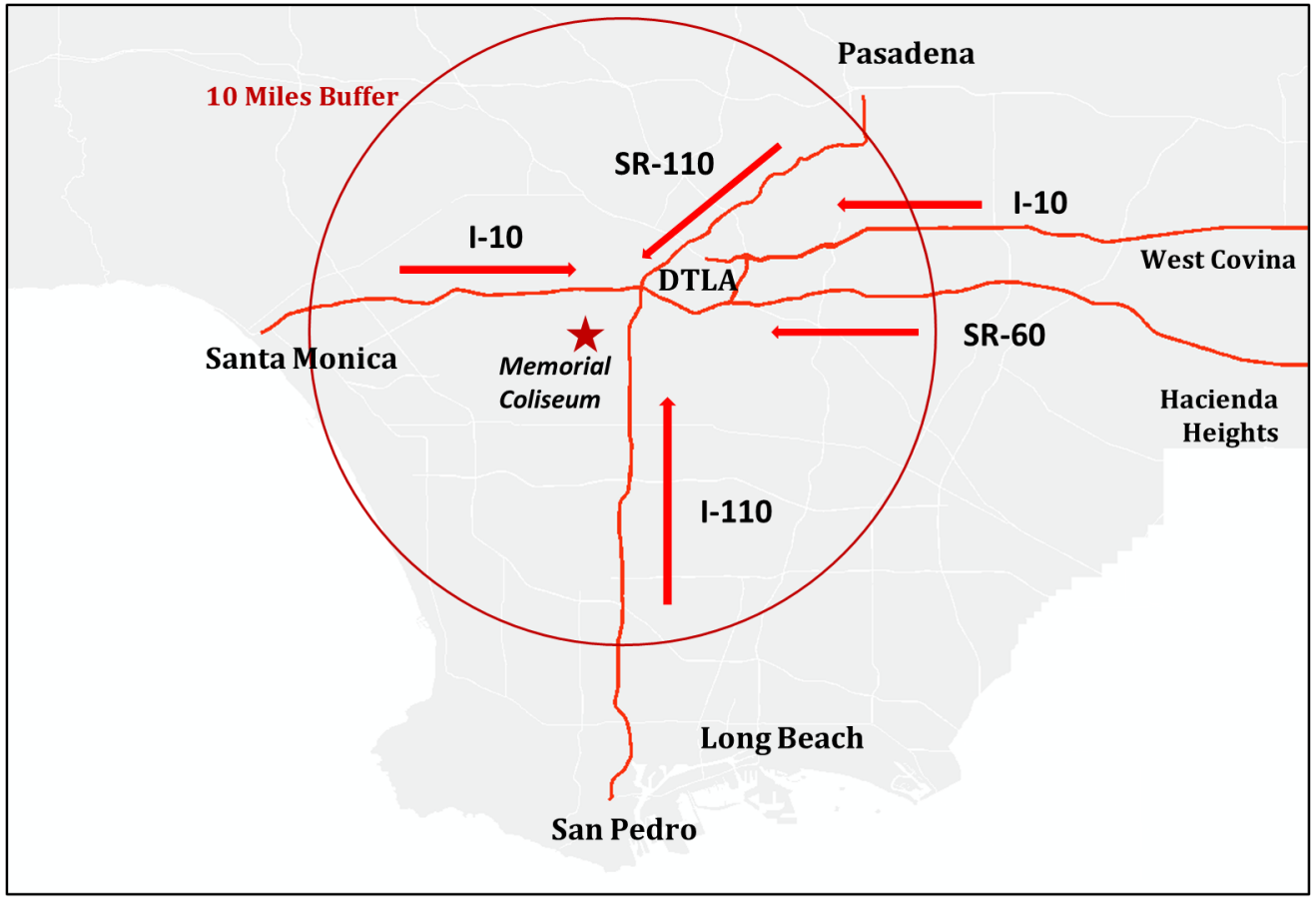
Research Questions

- How do weekend football games at the Coliseum affect local and regional transportation?
  - How do games affect the highway system?
  - How do they affect local arterials near the venue?

- What can event organizers and transportation planners do to mitigate these impacts?
  - More real-time traffic information?
  - Parking management?
  - Transit incentives?
  - Other ???

Study area

- **Los Angeles Memorial Coliseum**
  - Home of Los Angeles Rams and USC Trojans
- **Examine**
  - Highway traffic on major access corridors (within 10 miles)
  - Arterial traffic around Coliseum (within 5 miles)
- **Study Period**
  - Weekend football games
  - Jan 1, 2016 to Dec 31, 2018



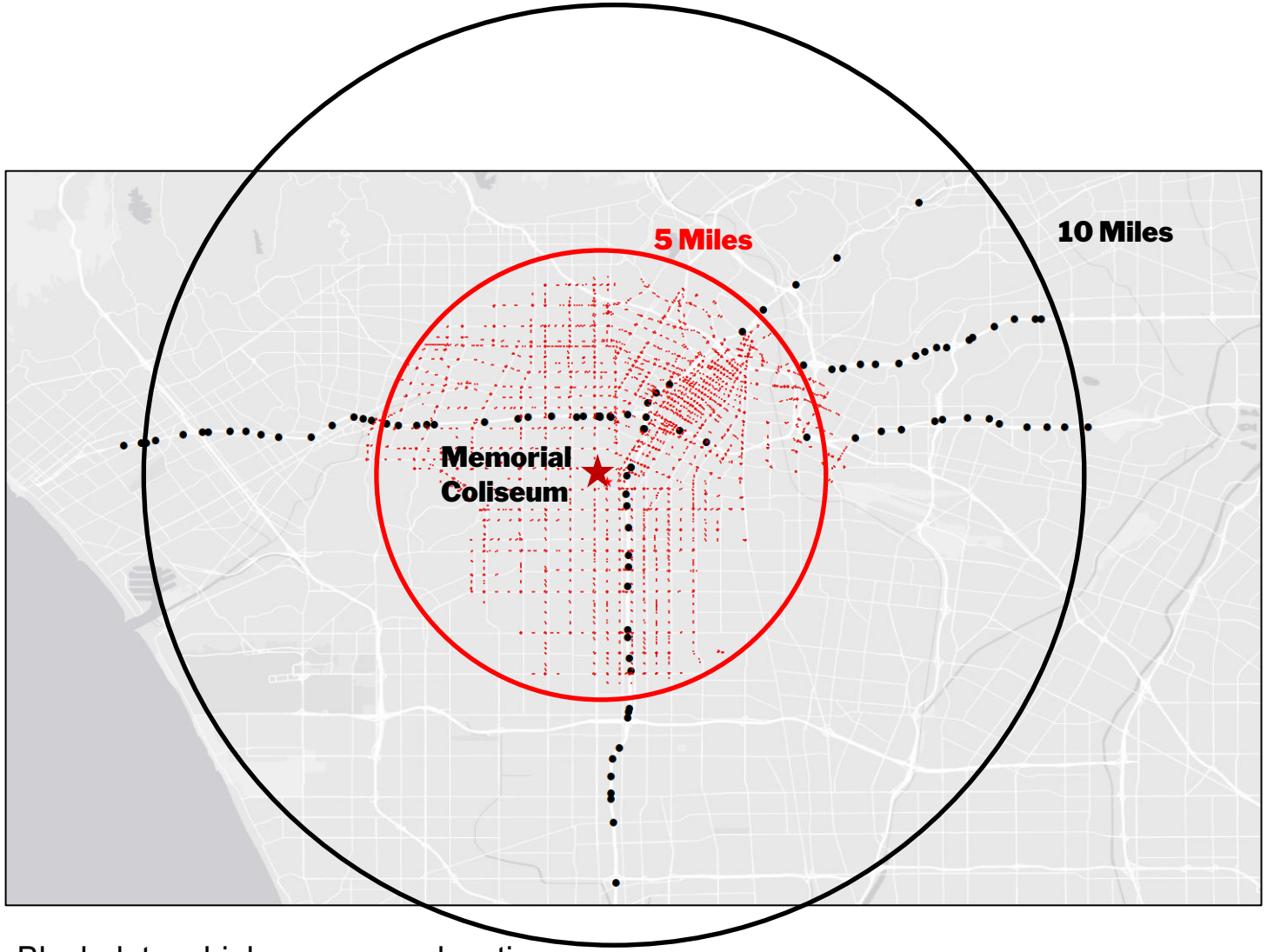
Study Area

Research approach

- **Compare game days with otherwise similar non-game days**
  - **Treatment group**
    - 19 Rams game days
    - 10 USC game days
  - **Control group**
    - 39 non-game days
    - Weekend days without major events
- Test for traffic speed difference between treatment and control days
- 0-6 hours before the football game kickoff, in 15 minute intervals

Data sources

- **Highways**: traffic speed by location, minute from Caltrans highway detectors, stored in the Archived Data Management System (ADMS)
- **Arterials**: traffic speed by location, minute from LADOT ATSAC detectors, stored in ADMS



Black dots = highway sensor locations
Red dots = arterial sensor locations

Pre-game traffic pattern- I 110 S

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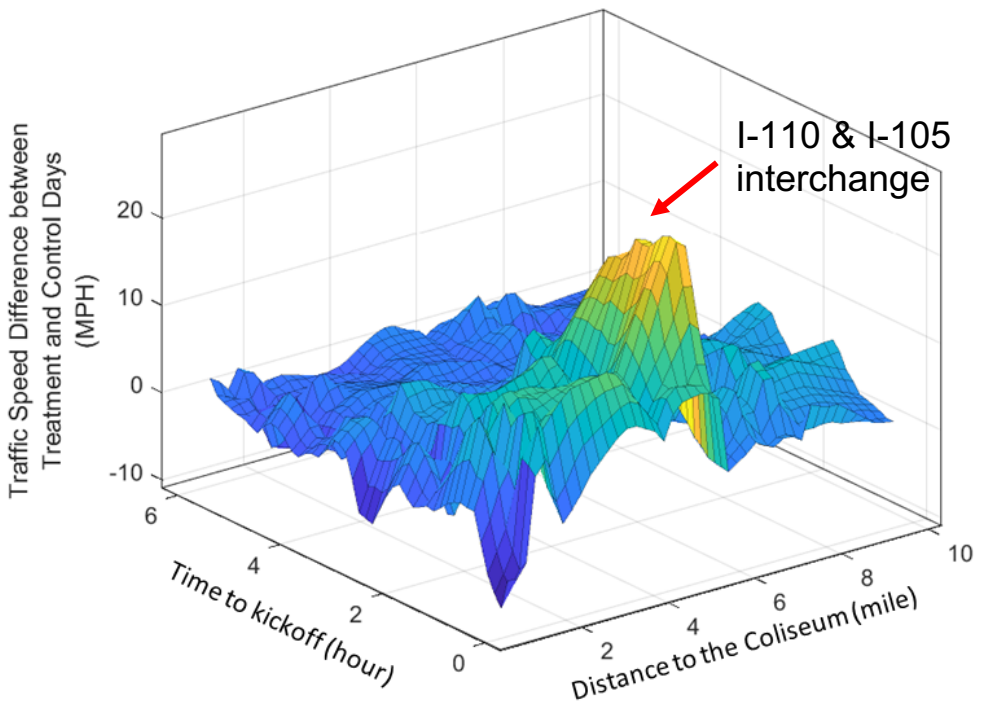
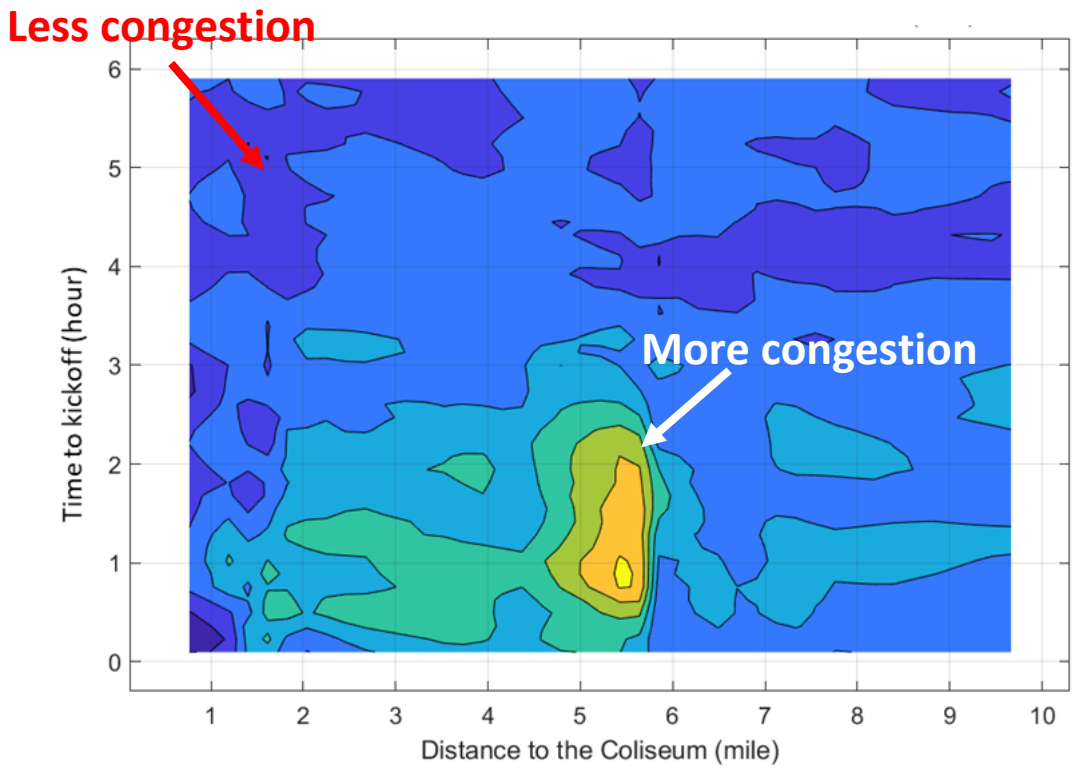
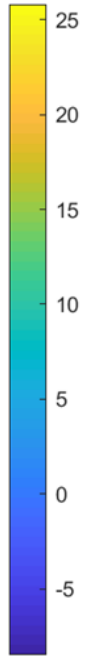
Rams games





Mile per hour



Pre-game traffic pattern- I 110 S

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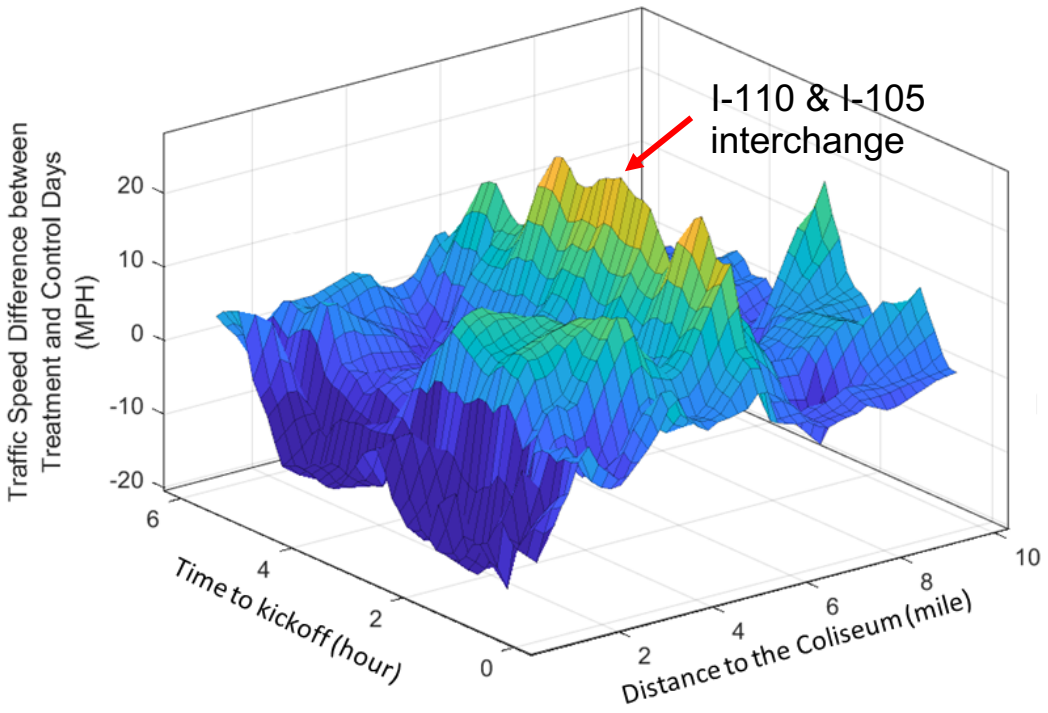
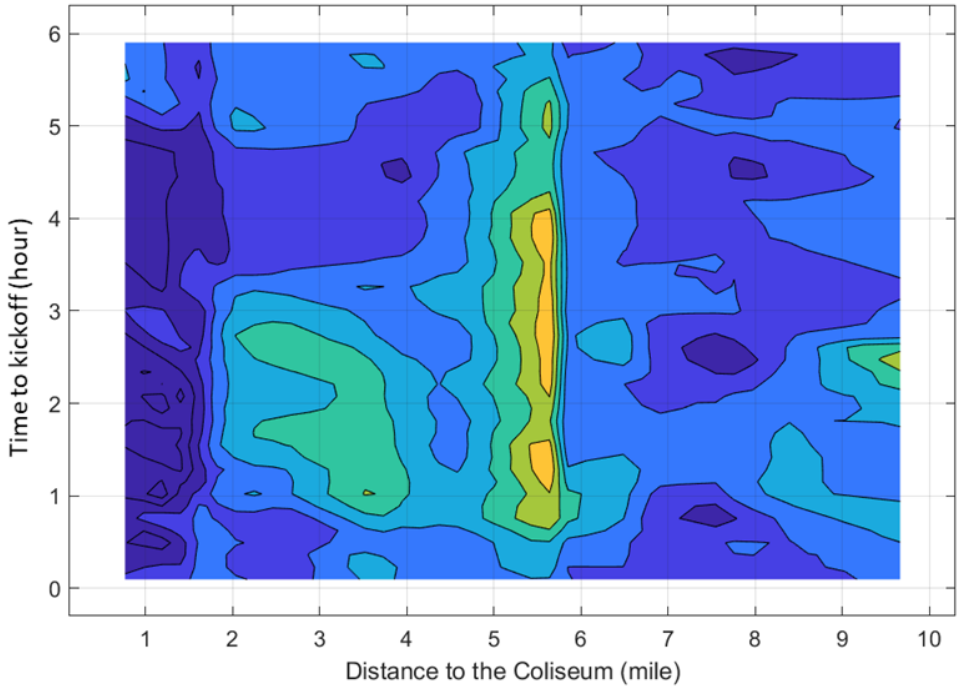
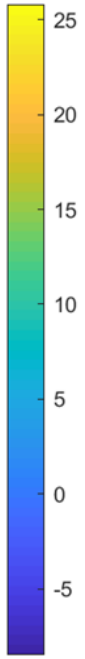
USC games





Mile per hour



Pre-game traffic pattern- Arterials

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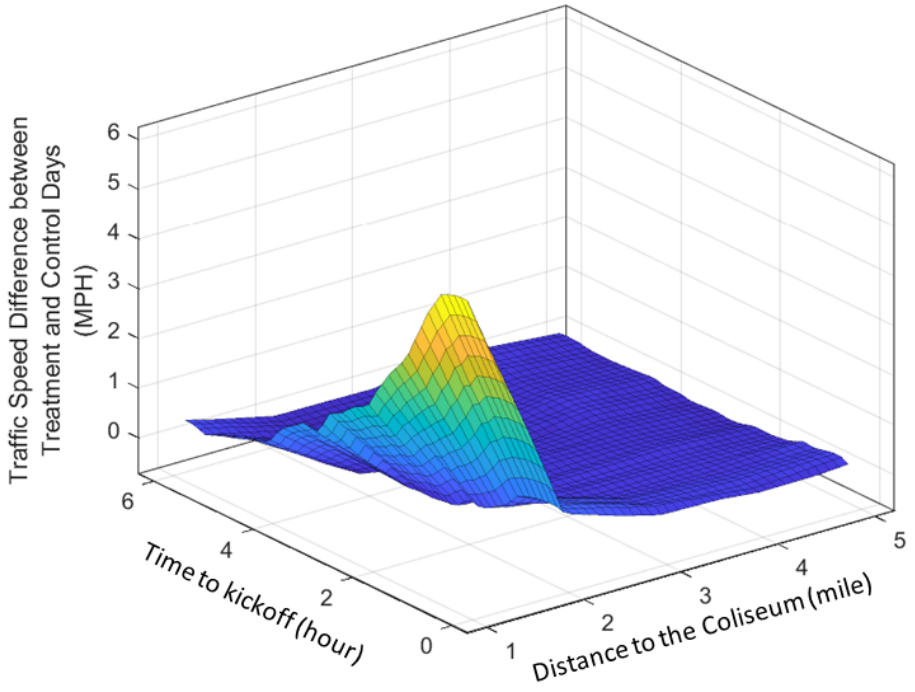
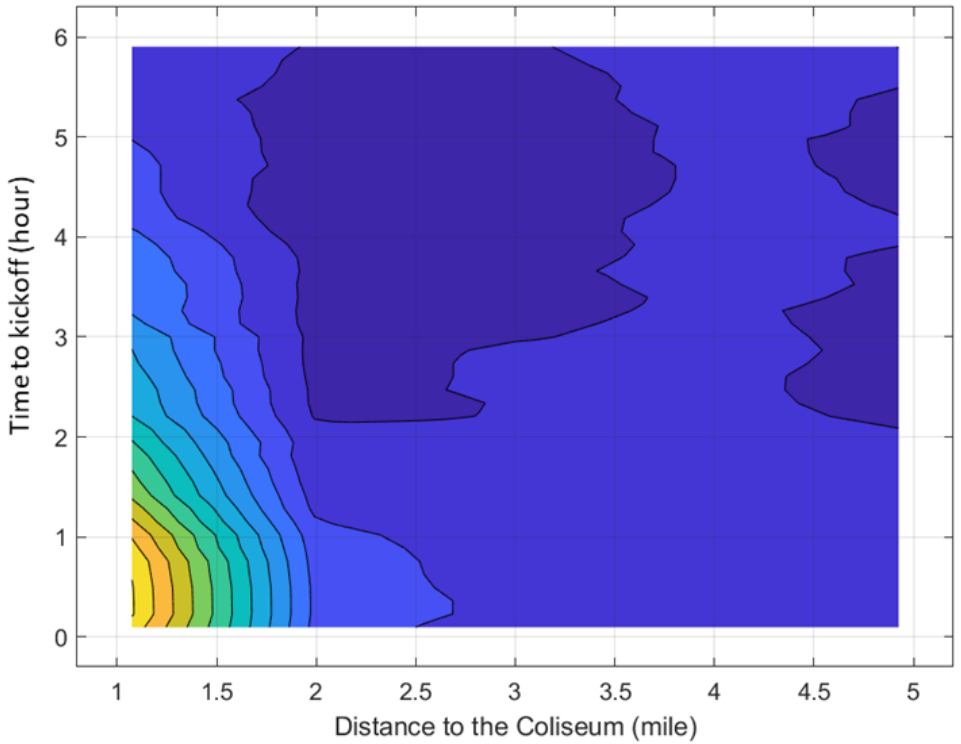
Rams games

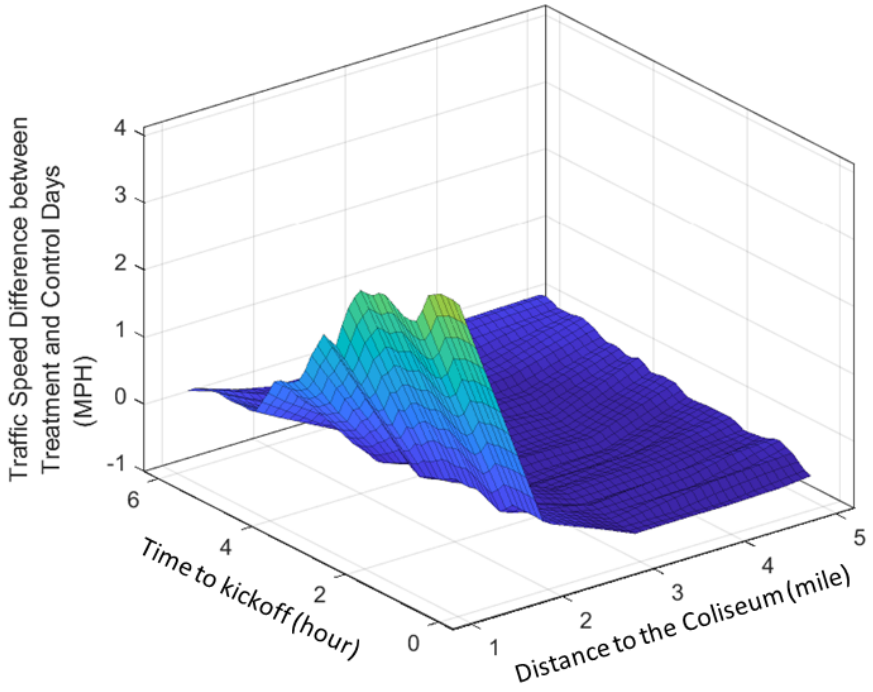


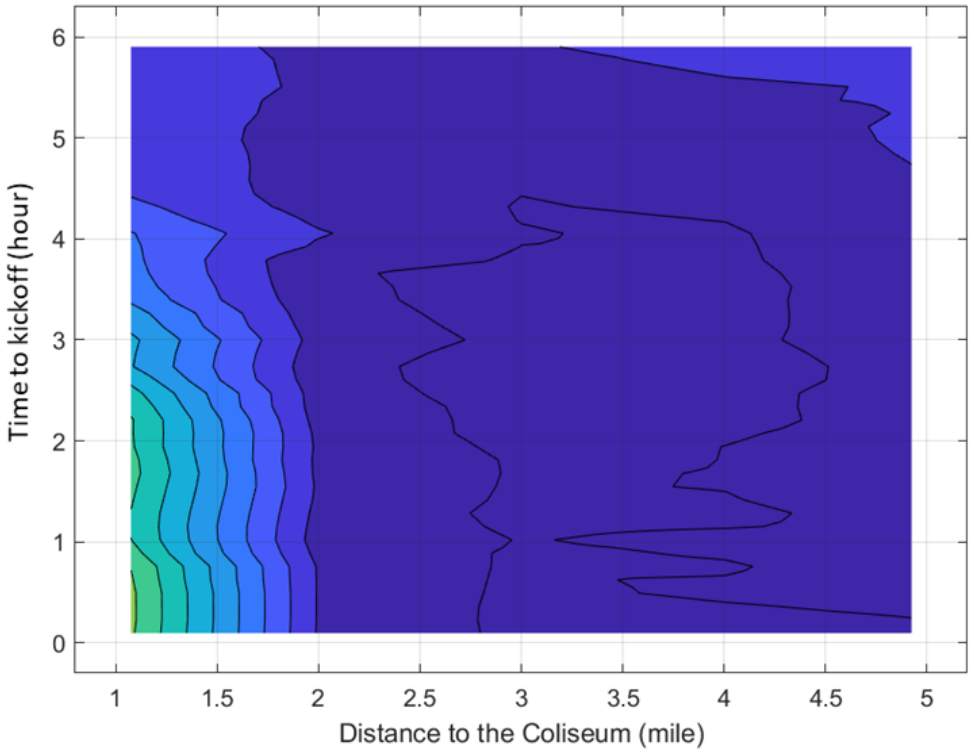


Mile per hour

Pre-game traffic pattern- Arterials

USC games





Mile per hour

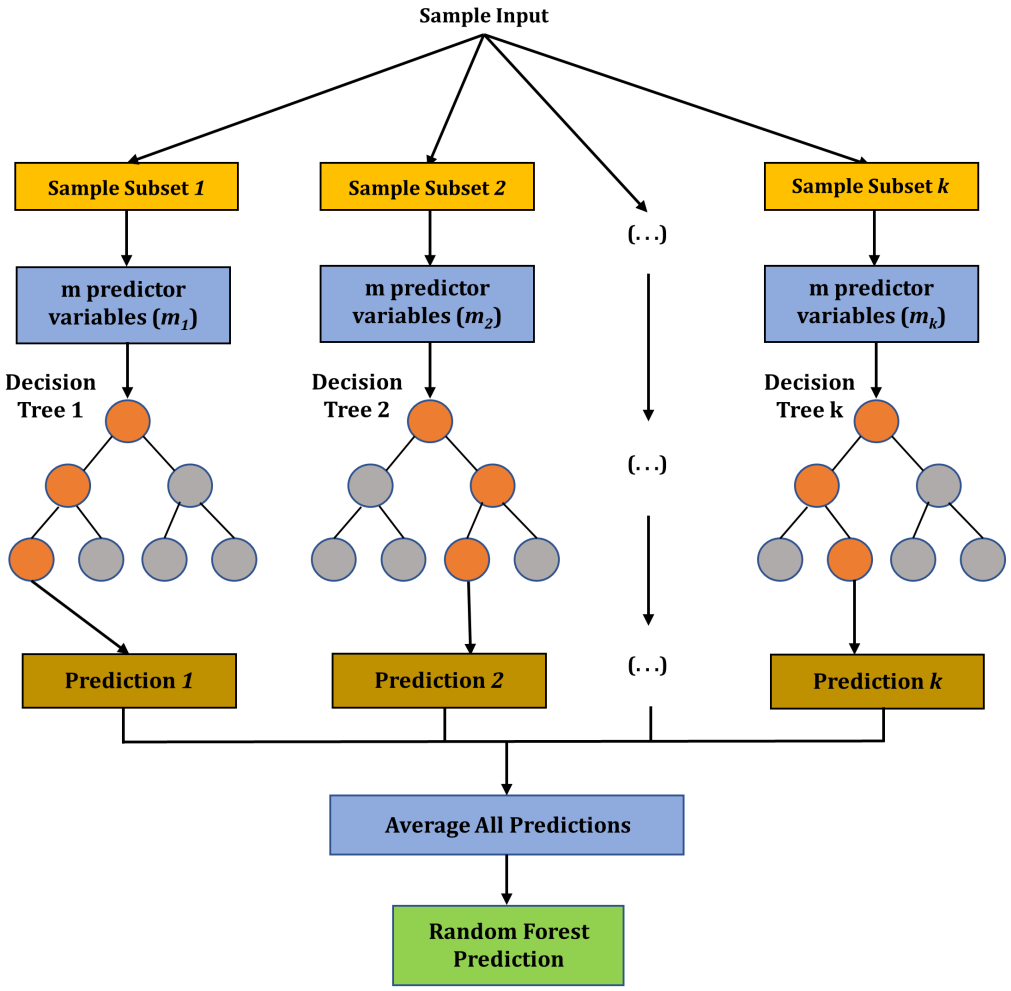
Estimate game-day traffic

$\Delta\ s_i$: Traffic speed difference at traffic detector *i* between game days and control non-game days as a function of:

Temporal autocorrelation	15-minute lagged speed difference for detector *i*
Spatial autocorrelation	Weighted traffic speed difference of nearby detectors at the same highway corridor
Temporal effect	Time to game kickoff in 15-minutes interval
Spatial effect	Distance of detector *i* to Coliseum
Control variables	Game attendance number, kickoff time dummy variables
Fixed effects	Year, month fixed effects

Two models

- Model 1. **Ordinary Least Square (OLS)**
  - Linear regression
  - With spatial and temporal lags
- Model 2. **Random Forest (RF)**
  - Machine learning algorithm
  - Accounts for non-linear relationships
  - Provides ranking of variable importance



Structure of a Random Forest model

Result: OLS model

- The **spatial** and **temporal lag** coefficients are highly significant and account for most of the variance explained by OLS model.
- Other variables are of the expected signs but often not statistically significant.
- OLS does not account for complex nonlinear relationships between response variable and predictor variables.

OLS results for Rams games

Independent variable	I-110 N	I-110 S	I-10 W	I-10 E	Arterials
Time lagged term	+	+	+	+	+
Spatial lagged term	+	+	+	+	+
Distance to Coliseum	-		-		-
Time to kickoff			+		-
Distance to highway interchange	-	-	-	+	
Attendance number					
AM game dummy			+		
PM game dummy					

Signs of significant coefficients only.

Result Comparison: OLS and RF

	OLS		RF	
Rams	**R^2**	**RMSE**	**R^2**	**RMSE**
1-110 S	0.70	6.04	0.90	4.03
I-110 N	0.73	6.54	0.88	3.84
I-10 W	0.72	4.81	0.88	3.18
I-10/SR 60 E	0.59	3.48	0.83	2.32
Arterials	0.40	3.42	0.75	2.35

USC	**R^2**	**RMSE**	**R^2**	**RMSE**
I-110 S	0.77	7.08	0.92	4.17
I-110 N	0.76	7.17	0.85	3.76
I-10 W	0.79	6.38	0.90	3.55
I-10/SR60 E	0.58	3.85	0.82	2.43
Arterials	0.39	3.38	0.76	2.28

- RF model performs better than OLS in all cases.
- RF allows for many different variable transformations.
- RF also allows for different combinations of variables and different relationships between the independent variables.

Non-linearities in spatio-temporal patterns: Highways

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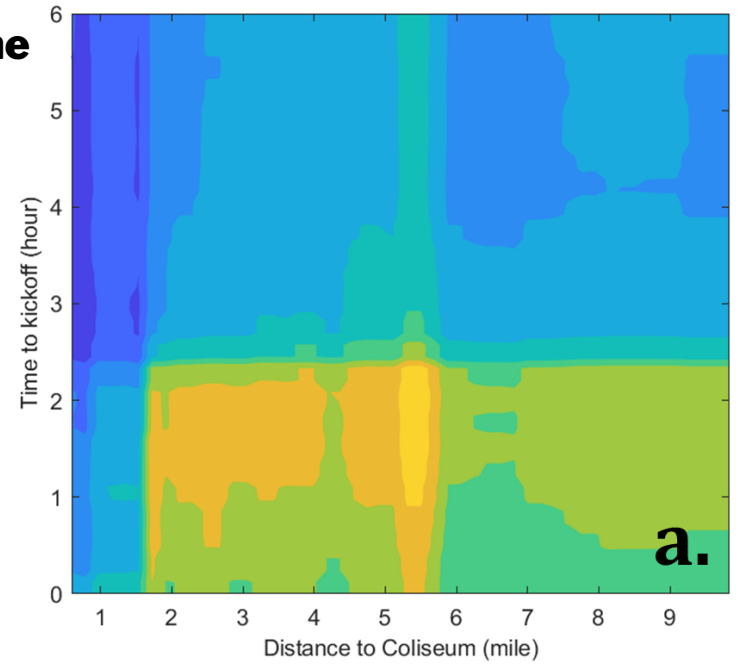
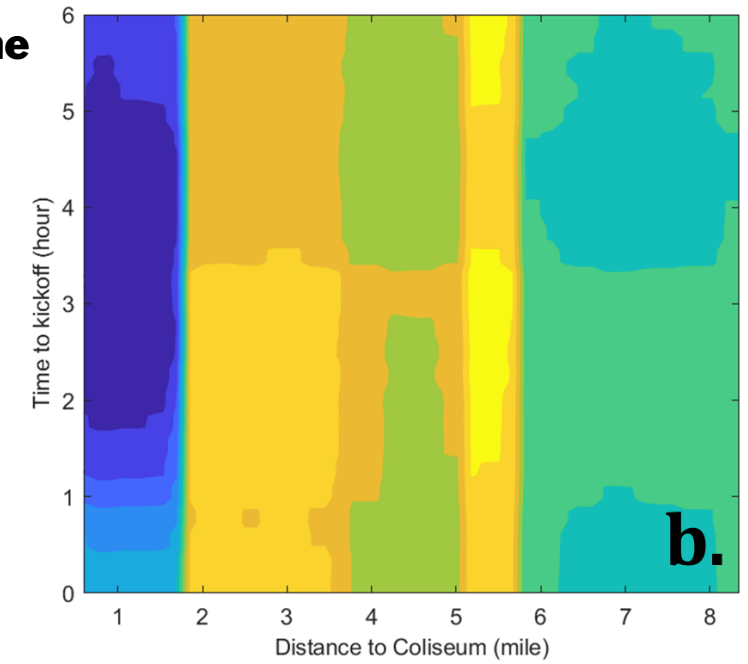
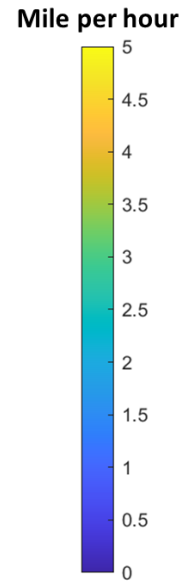
Rams game



USC game



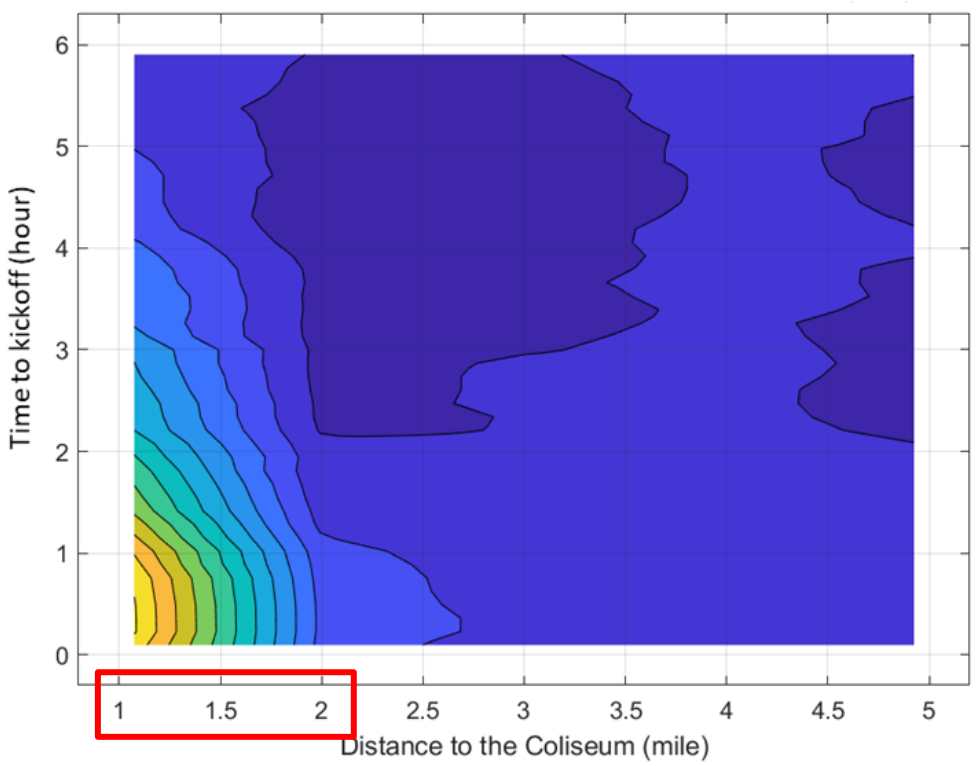


- **Rams** attendees tend to arrive 2-3 hours prior to the start of a game, while **USC** attendee arrive up to 6 hours earlier, due to the tailgating.
- Significant **non-linear** relationship between time and distance on freeways.
- Greatest impacts of game induced traffic on freeways tend to be around existing **interchange** bottlenecks, rather than closest to the Coliseum.
- Similar pre-game traffic on freeways from north-bound and south-bound on I-110, and east-bound and west-bound on I-10 and SR-60.

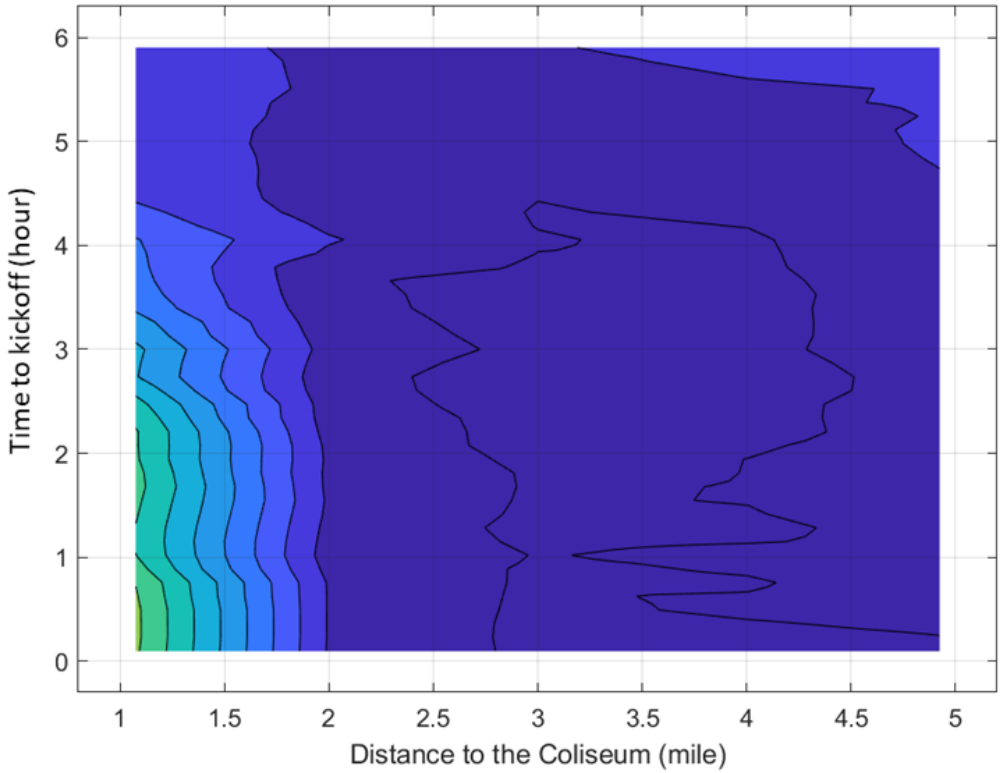
Linearities in spatio-temporal patterns: Arterials

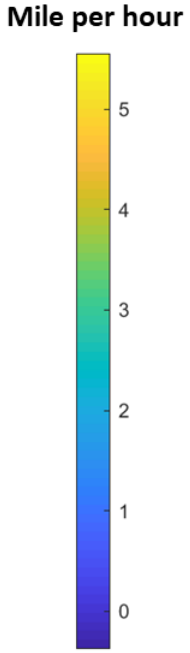
- More **linear** relationship between time and distance on arterials.
- Game induced traffic for arterials is limited to within two miles.
- Rams arrival pattern is more concentrated in time than USC.

Rams game



USC game





Findings

- Dissimilar arrival pattern for Rams and USC games. Rams game attendees have a more concentrated arrival pattern.
- More complicated pre-game traffic on highways than arterials.
- For highways, greatest impacts of game induced traffic on freeways tend to be around existing interchange bottlenecks.
- For arterials, the impact of game induced traffic is limited to within two miles of the Coliseum.

What might be done to reduce congestion?
…..some preliminary results

Possible options

1. Stagger attendees' arrival pattern
2. Encourage attendees to take public transit
3. Do both

Method: Simulation modeling

Simulation 1:
Move 50% of game traffic in 3 to 0 hour time interval to 6 to 3 hour time interval

Simulation 2:
Reduce game traffic demand by 20%

Simulation 3:
Both time shifting and demand reduction

- Use VISSIM to build a network simulation model of the Coliseum area
- Use traffic data to simulate demand on the network
- Compare results to base case (no intervention)
- Simulation parameters
  - 1 PM Rams game
  - Time period: 6 to 0 hours before game

Simulation 1 results

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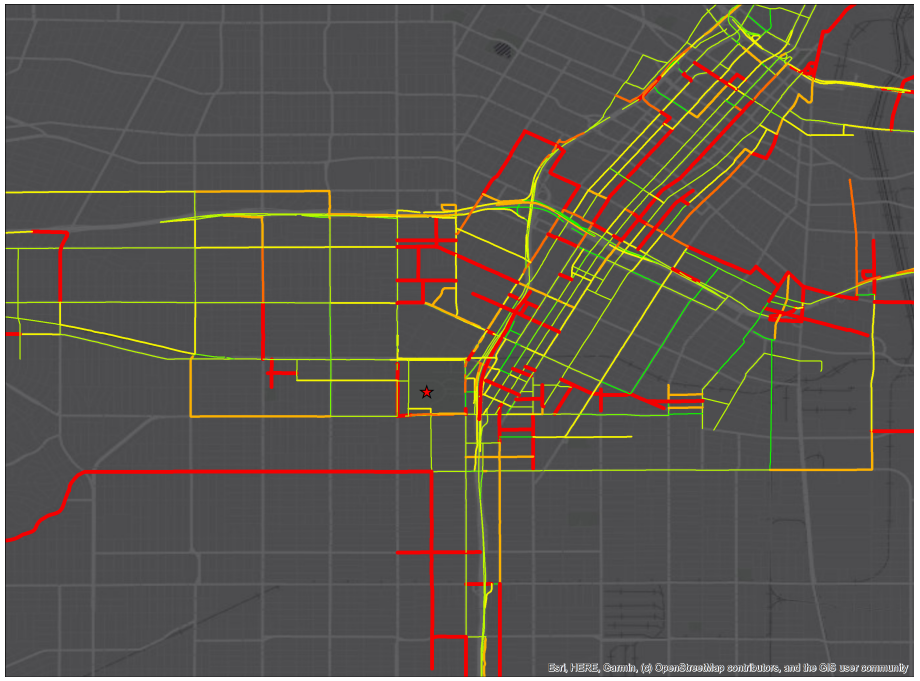
0-3 hours before the game

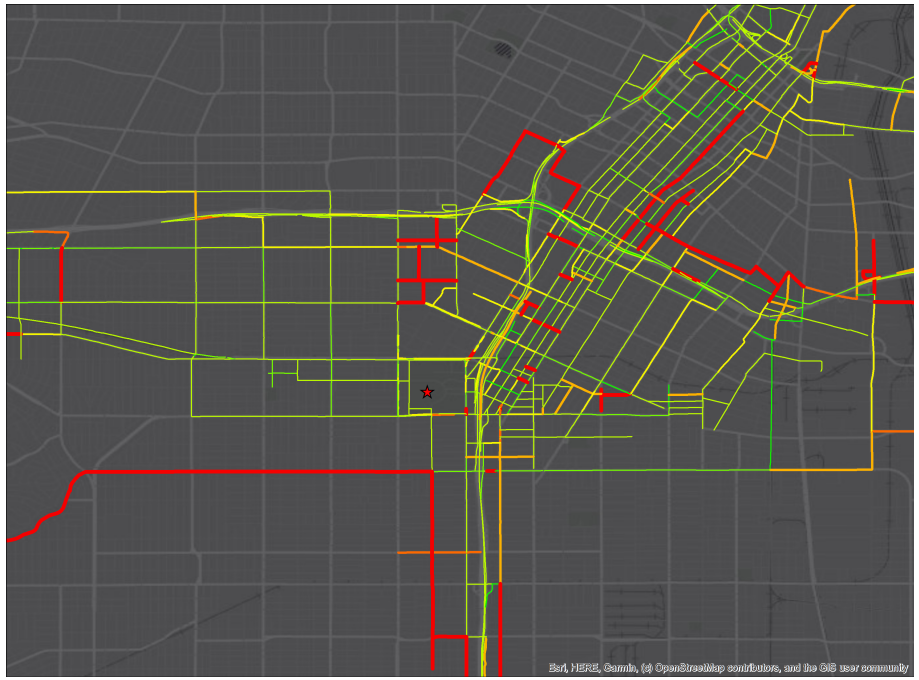


3-6 hours before the game

	0-3 hours before the game			3-6 hours before the game		
	Before VMT	After VMT	Change	Before VMT	After VMT	Change
Overall	229199	188529	-17.74%	132247	145290	9.86%
Arterial (within 2miles)	28432	23156	-18.56%	14447	15805	9.40%
Highway	158925	133647	-15.91%	101852	111941	9.91%

Simulation 2 results

0-3 hours before the game



3-6 hours before the game

	0-3 hours before the game			3-6 hours before the game		
	Before VMT	After VMT	Change	Before VMT	After VMT	Change
Overall	229199	212148	-7.44%	132247	133474	0.93%
Arterial (within 2miles)	28432	26091	-8.23%	14447	14450	0.02%
Highway	158925	149033	-6.22%	101852	102569	0.70%

Simulation 3 results

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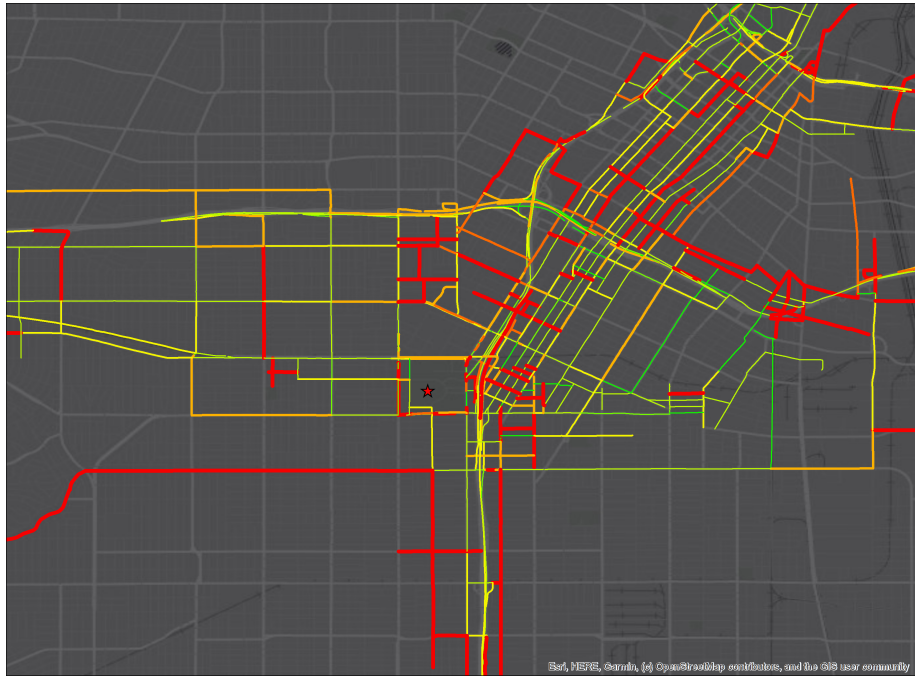
0-3 hours before the game



3-6 hours before the game

	0-3 hours before the game			3-6 hours before the game		
	Before VMT	After VMT	Change	Before VMT	After VMT	Change
Overall	229199	179366	-21.74%	132247	146111	10.48%
Arterial (within 2miles)	28432	21892	-23.00%	14447	15836	9.62%
Highway	158925	128078	-19.41%	101852	112481	10.44%

Conclusions

- Simulation provides a useful way to evaluate possible policy strategies
- For RAMS games, spreading demand over a longer time period would reduce total congestion
  - Effectiveness of demand spreading strategy depends on overall temporal demand on the system
- The difference between spreading demand and shifting to public transit is the result of assumptions on how much demand is shifted
- Simulations assume incentive strategies – part of the research project
- Case study findings are generalizable to other major events in other locations

Thank You

Acknowledgement: This research is supported by the Los Angeles Metropolitan Transportation Authority under the LA SAFE program. Findings do not necessarily reflect the views or policies of the sponsor. All errors and omissions are the responsibility of the authors.