RESEARCH PORTFOLIO

ABSTRACT PRESENTATIONS

GOKTUG ISLAMOGLU

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ITS SUMMIT 2019 Presentation

NECSI ICCS 2020 Presentation

NERCCS 2021 Poster Presentation

CONFERENCE PRESENTATIONS: ABSTRACTS

FUNDAMENTALS AND METHODOLOGY

1. FUNDAMENTALS: ONE-TO-MANY & MANY-TO-MANY CONGESTIONS AND CRASHES
2. METHODOLOGY: OPTIMAL DRIVING FORMATION AND ZIPPER MERGING

INFORMS 2018 ANNUAL MEETING: SESSION CHAIR & ABSTRACT PRESENTATION

3. ONE-TO-MANY AND MANY-TO-MANY CRASHES IN ISTANBUL AND CHARACTERISTICS

ITS SUMMIT 2019: ORAL PRESENTATION

4. ROAD DEMAND AFFECTING NOT ONLY CONGESTION, BUT CRASHES AS WELL
5. VEHICLE TYPES INFLUENCING MANY-TO-MANY CRASHES IN TURKEY

ICCS 2020: ABSTRACT PRESENTATION

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7. EXACT ANALYTICAL SOLUTION OF FERROMAGNETISM: BEYOND CURIE-WEISS LAW

FUNDAMENTALS: ONE-TO-MANY CONGESTION

BOTTLENECKS AND ZIPPER MERGE

Usually one-to-many congestions happen at bottlenecks, such as Istanbul's bridges on the right. If **zipper merge** is not maintained, the bottleneck may generate congestions, especially long in rush hours.

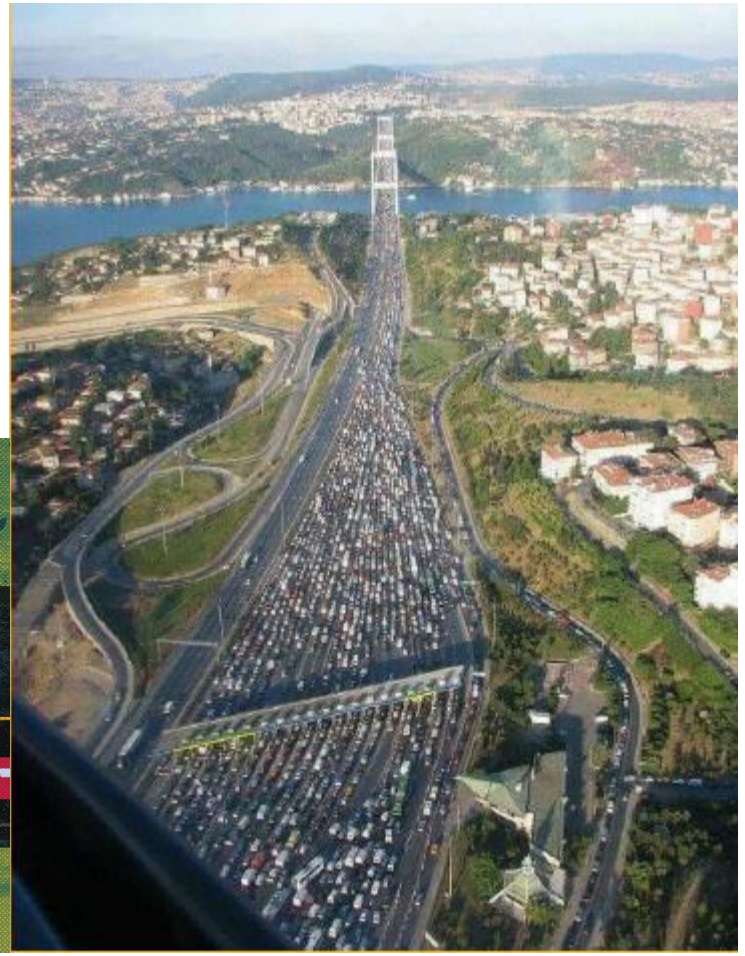


Image 1 - https://twitter.com/erikwest73/status/1031842127918125057
Netherlands Entreprise Agency Report: - https://www.rvo.nl/sites/default/files/2018/08/Who-need-cars-anyway.pdf
Image 2 - https://amainsider.com/zipper-merge/

FUNDAMENTALS: ONE-TO-MANY CRASHES

REAR-ENDING: SUDDEN BREAKING AND ACCELERATION

Behind bottleneck congestions, if the incoming flow is high speed, read-end collisions are commonplace. On the other end of the congestion, once the road is cleared, the irritated drivers stomp their feet on the gas, causing disruption. Erratic driving of autonomous vehicles is the dominant cause of humans rear-ending them.

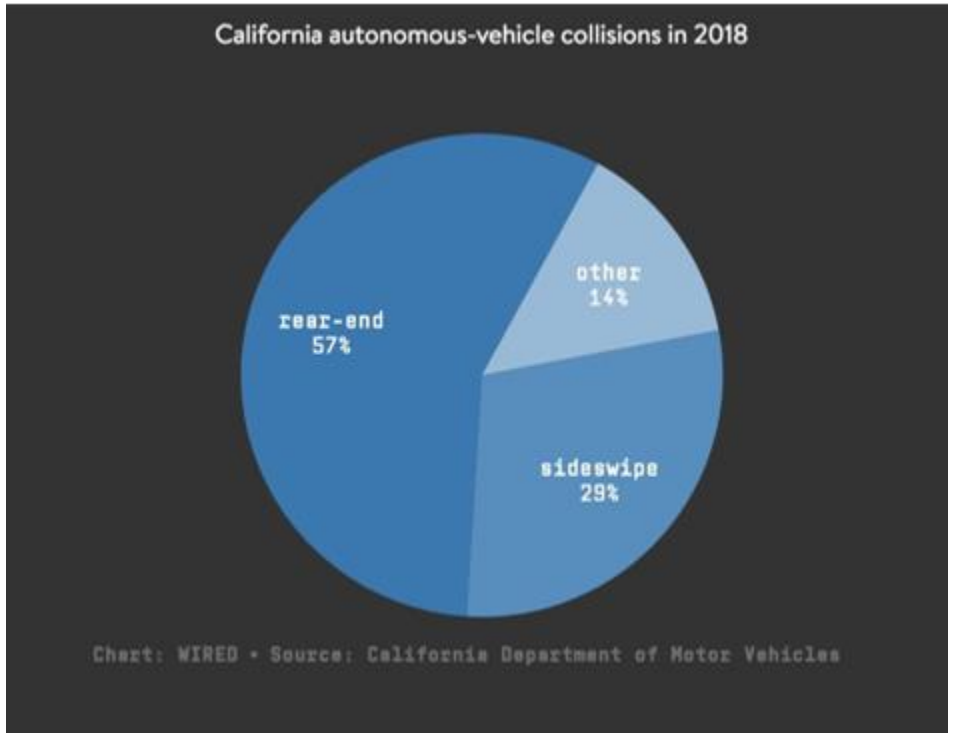


Image - https://www.wired.com/story/self-driving-car-crashes-rear-endings-why-charts-statistics/

FUNDAMENTALS: MANY-TO-MANY CONGESTION

CONGESTION (in my terms)

When in one time frame, if two vehicles attempt to pass through a road section able to accommodate one vehicle at that one time frame, congestion occurs if one of the vehicles **fall in queue**. This queue may extend backwards depending on other vehicles joining the road.

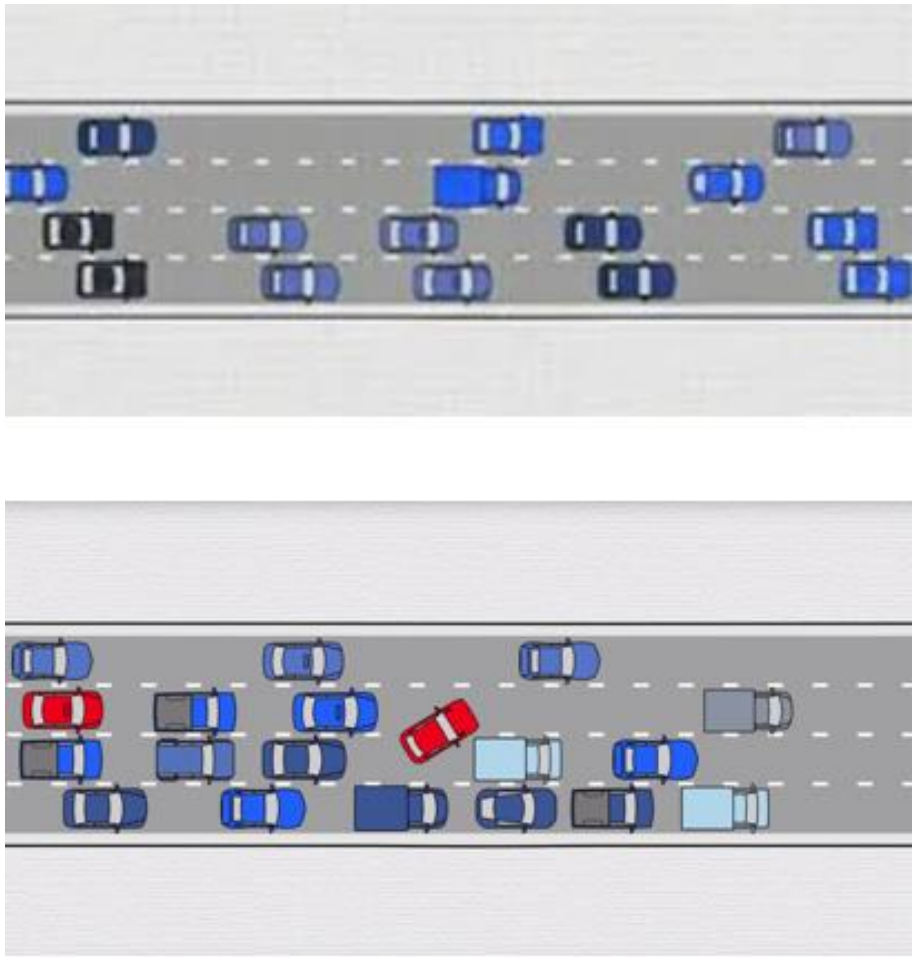


Image: Traffic jams created by merging – https://www.youtube.com/watch?v=2Loi9YyOz4k

FUNDAMENTALS: MANY-TO-MANY CRASHES

CRASHES (between two vehicles)

When in one time frame, if two vehicles attempt to pass through a road section able to accommodate one vehicle at that one time frame, a crash occurs if one of the vehicles **end up on sharing the same road space at the same time,** stopping, blocking the road passage.

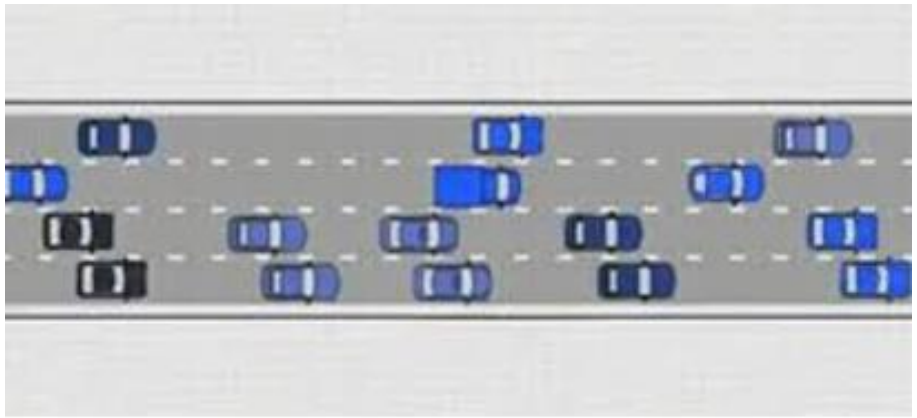
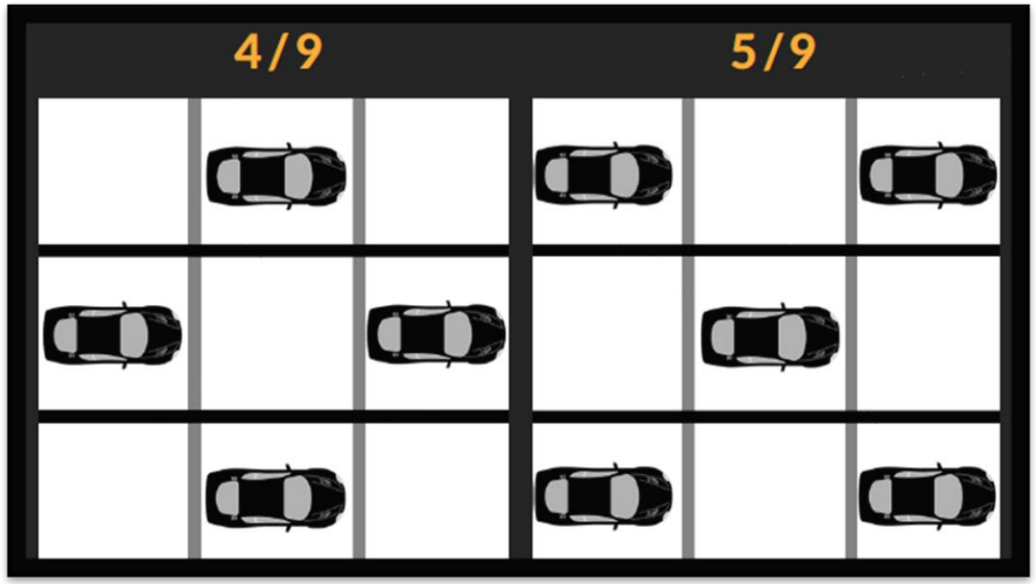


Image: Traffic jams created by merging – https://www.youtube.com/watch?v=2Loi9YyOz4k

METHODOLOGY: TRAFFIC FORMATION

Hypothetical optimal traffic formation: **continuous zipper merge or, checkerboard**

Allowing vehicles to move forward and merge sideways, causing no disruption to the traffic flow.

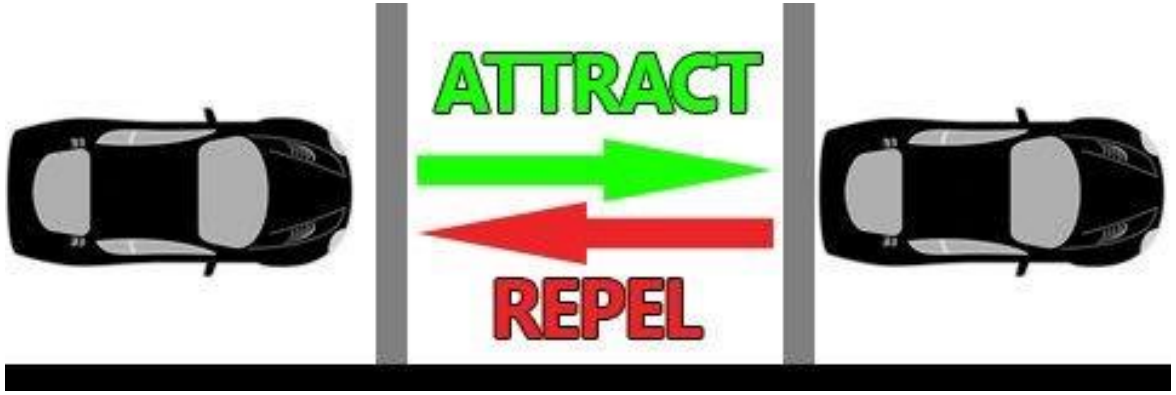


Physics of formation was presented at NECSI ICCS 2020, NERCCS 2021 conferences on complex systems.

METHODOLOGY: ZIPPER FLEXIBILITY

Continuous zipper merging can form one empty lane on demand.

This use is reserved for emergency vehicles. Vehicles in side demagnetize the flow: physics in the previous slide.



1 - https://www.reddit.com/r/videos/comments/5zx8ar/drivers_in_germany_form_an_emergency_corridor_on/

INFORMS 2018 *PHOENIX, AZ, UNITED STATES*

Institute for Operations Research and the Management Sciences

SESSION CHAIR[1]

ABSTRACT PRESENTATION[2]

1 - www.abstractsonline.com/pp8/#!/4701/session/2099
2 - www.abstractsonline.com/pp8/#!/4701/presentation/19295

ONE-TO-MANY, MANY-TO-MANY: ISTANBUL

Crash focus Istanbul D100 Roadway:

- Spans from European to Asian side, connected by 1st Bridge of Istanbul
- Surrounded by very dense population
- Formerly E-5 highway, lost highway status :
  - Bus-Rapid Transit (Metrobüs) protected road built in 2011, both shrunk the lane width and occupied one lane on each direction
  - Entry into highway not managed exclusively through access roads, especially near airport
  - Highway travel speeds not maintained

Dataset: Istanbul Municipality's Transport Management Center Twitter: Dec 2016 - Mar 2017[1]

Outdated Data: In the above time period, Istanbul Ataturk Airport was still operational. On April 2019, the decommissioning of Ataturk Airport greatly altered the traffic conditions.

1 - https://twitter.com/4444154, Twitter API

ONE-TO-MANY: MONDAY MORNING CRASHES

D100 KUCUKCEKMECE BOTTLENECK CRASHES ON MONDAY MORNINGS

Hour Range	Mon
3	1
5	2
7	4
8	4
10	1
11	1
12	4
13	2
14	1
15	1
16	1
18	2
19	2
20	1

Insurance Information and Monitoring Center (SBM): In 2014, highest number crashes happened on Mondays in Istanbul[1].

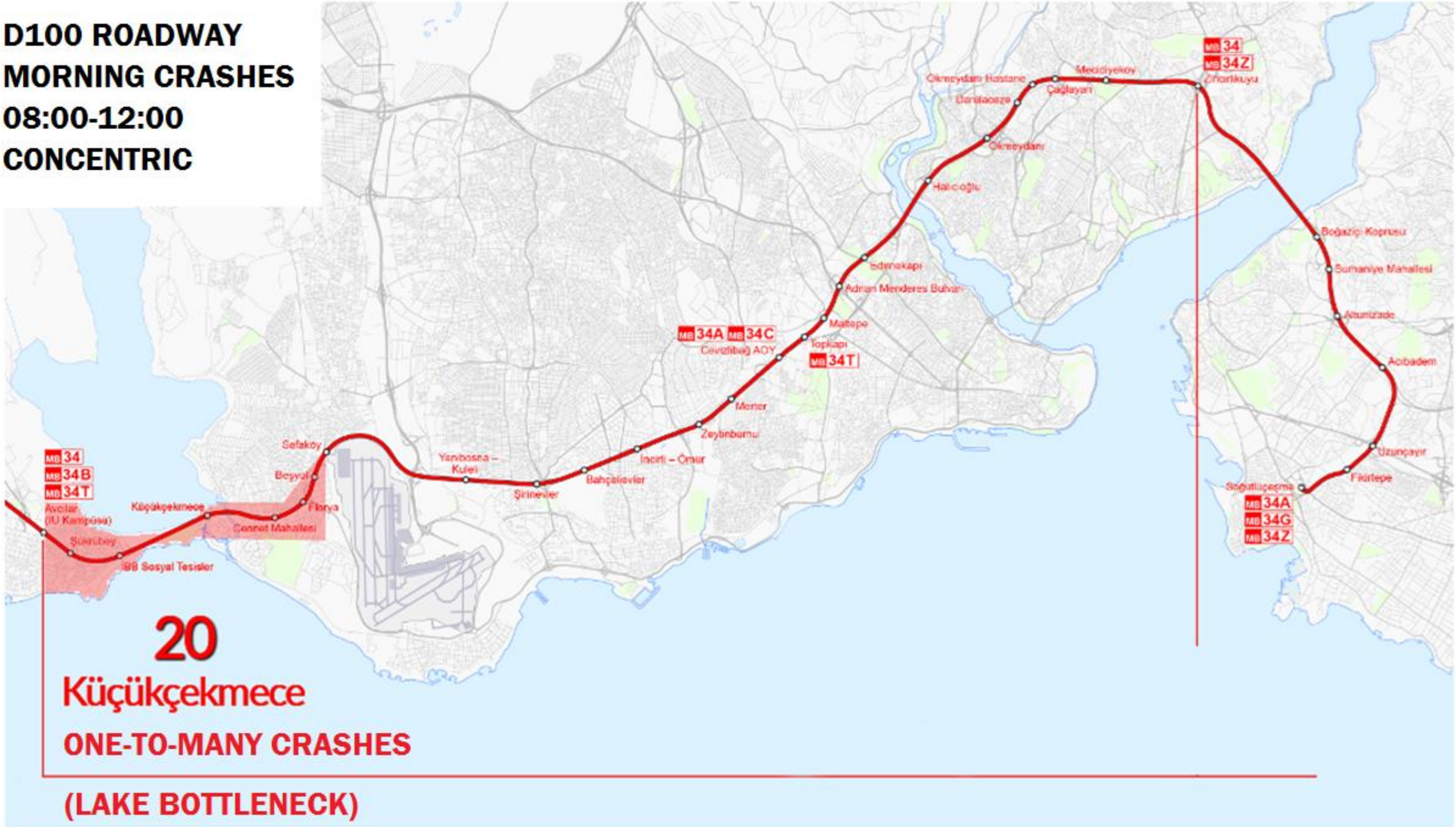
REST OF ISTANBUL PROPER CRASHES ON MONDAY MORNINGS

3	2
4	4
5	7
6	9
7	13
8	5
9	6
10	7
11	3
12	5
13	9
14	1
15	4
16	3
17	5
18	3
19	1
20	1

D100 Küçükçekmece crashes on **Monday 08.00** and **12.00** are **disproportionately high** compared to the rest of three-months dataset.

1 - https://www.wsj.com/articles/trafikte-pazartesi-sendromu-1405253239

D100 ROADWAY
MORNING CRASHES
08:00-12:00
CONCENTRIC



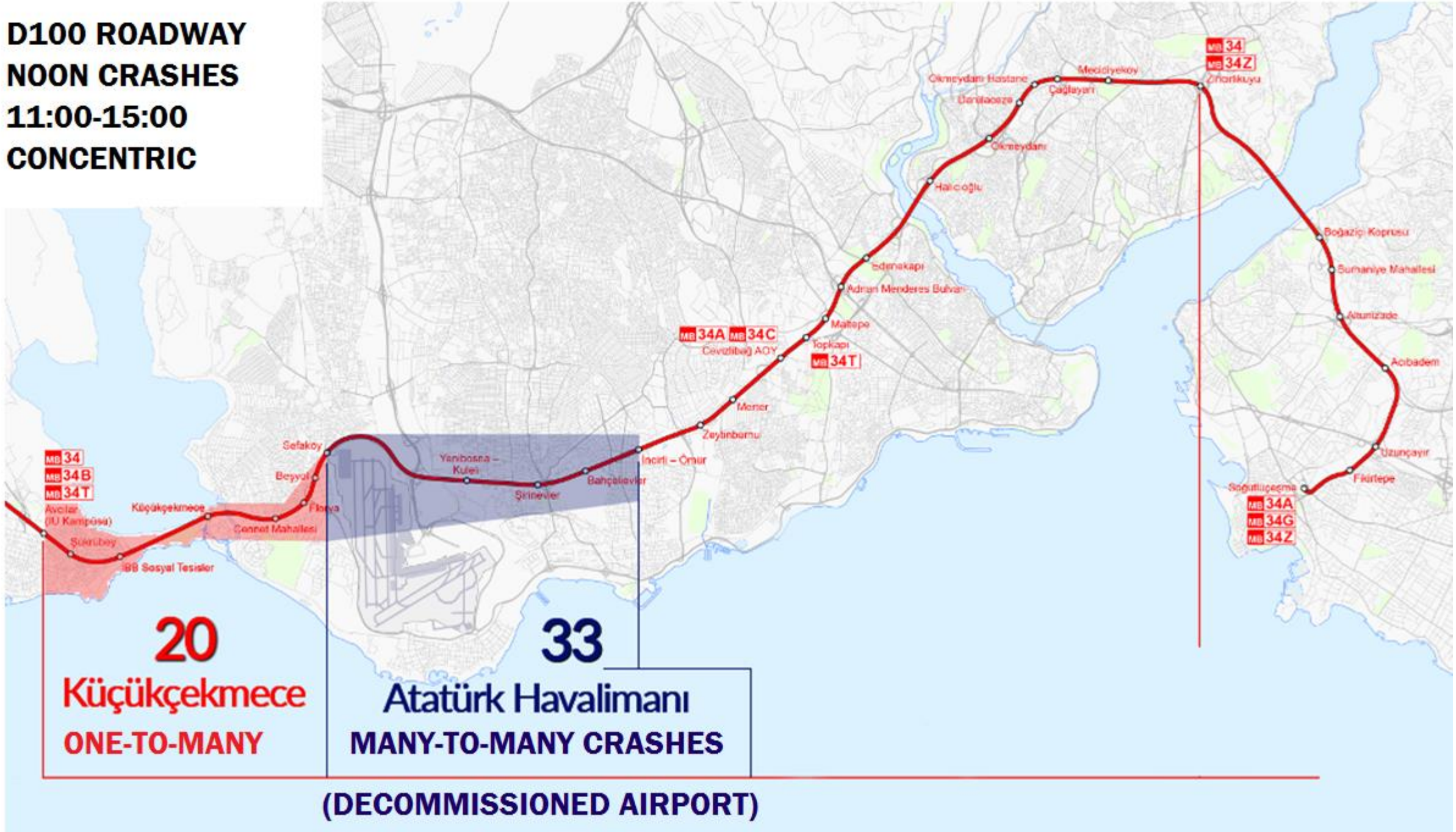
20

Küçükçekmece

ONE-TO-MANY CRASHES

(LAKE BOTTLENECK)

D100 ROADWAY
NOON CRASHES
11:00-15:00
CONCENTRIC

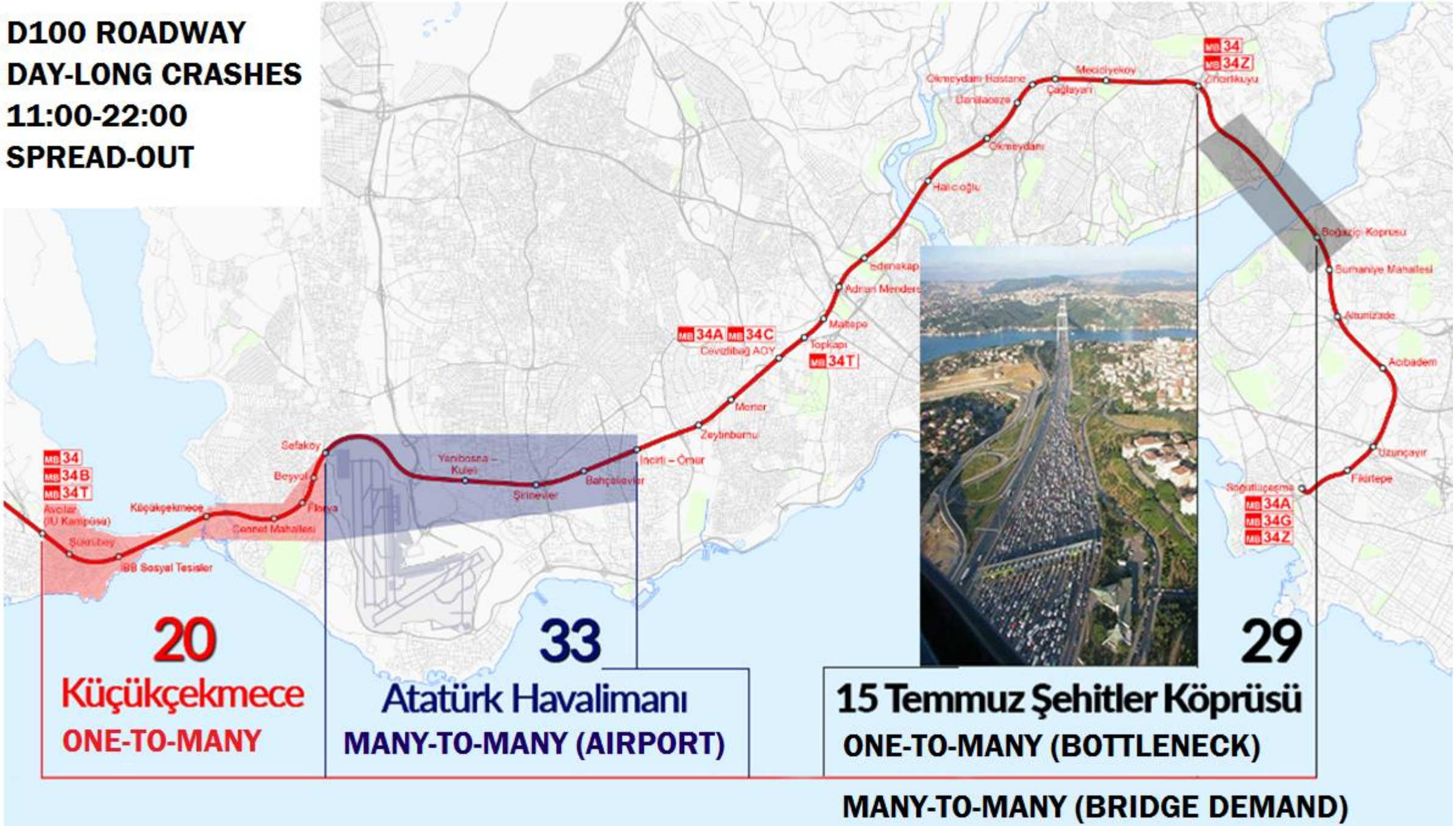


20
Küçükçekmece
ONE-TO-MANY

33
Atatürk Havalimanı
MANY-TO-MANY CRASHES

(DECOMMISSIONED AIRPORT)

D100 ROADWAY
DAY-LONG CRASHES
11:00-22:00
SPREAD-OUT



20
Küçükçekmece
ONE-TO-MANY

33
Atatürk Havalimanı
MANY-TO-MANY (AIRPORT)

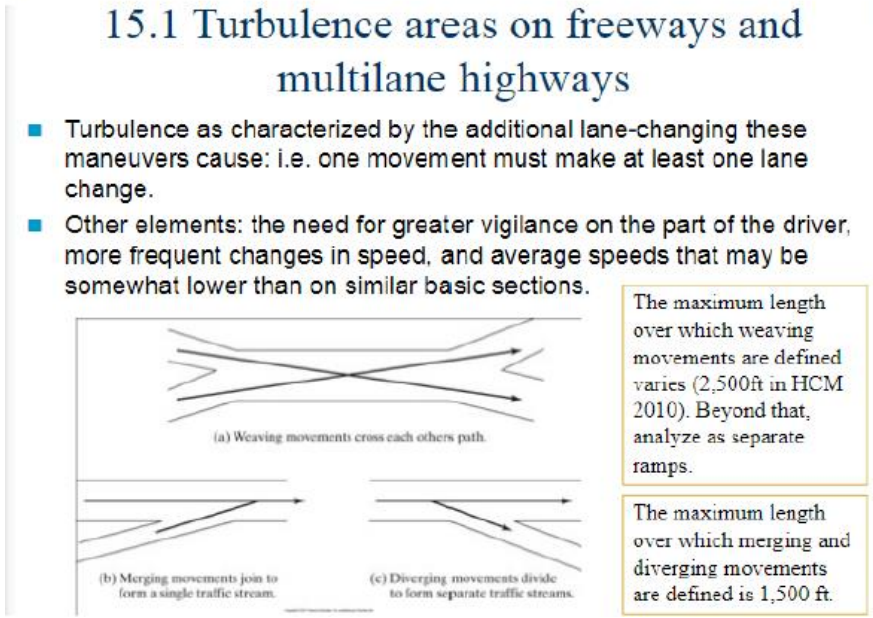
29
15 Temmuz Şehitler Köprüsü
ONE-TO-MANY (BOTTLENECK)

MANY-TO-MANY (BRIDGE DEMAND)

BAD ROAD DESIGN: AMPLIFYING CRASHES

D100 roadway in the now decommissioned Ataturk Airport area:

- Squeezed by BRT road on one side
- Squeezed by side road on the other side
- No access road to former highway D100, weave lane



15.1 Turbulence areas on freeways and multilane highways

- Turbulence as characterized by the additional lane-changing these maneuvers cause: i.e. one movement must make at least one lane change.
- Other elements: the need for greater vigilance on the part of the driver, more frequent changes in speed, and average speeds that may be somewhat lower than on similar basic sections.

(a) Weaving movements cross each others path.

(b) Merging movements join to form a single traffic stream.

(c) Diverging movements divide to form separate traffic streams.

The maximum length over which weaving movements are defined varies (2,500ft in HCM 2010). Beyond that, analyze as separate ramps.

The maximum length over which merging and diverging movements are defined is 1,500 ft.

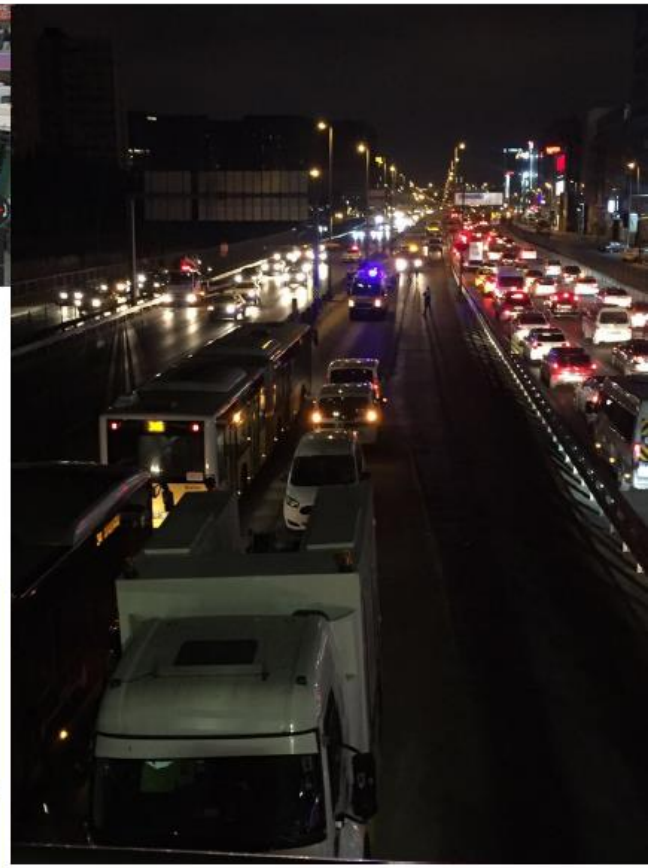


Photo 1 - Google Maps Street View – Şirinevler D100 Roadway and Side Road, Joining Ahead Without Access Road
Photo 2 – Goktug Islamoglu, Taken en Route to Airport, Şirinevler Metrobüs Stop. BRT Operations Stopped Due to Car Entering Protected Road
Image 1 - Traffic Engineering, Roger P. Roess / Elena S. Prassas / William R. McShane, Prentice Hall, Pearson .

PERSONALLY WITNESSED
CRASH: 30.05.2017 03:00

2017 - 6/7 ENTRIES OF VEHICLES INTO BRT ROAD
MERTER-SEFAKÖY AREA

MB 34
MB 34B
MB 34T
Avcılar (İÜ Kampüsü)
Şükrübey
BB Sosyal Tesisler
Küçükçekmece
Cennet Mahal
Florya
Beşyol
Sefaköy
1
Yenibosna – Kuleli
Şirinevler
2
3
Bahçelievler
İncirli – Çınar
4
Merter
Zeytinburnu
5
MB 34A MB 34C
Cevizlibağ AOY
Topkapı
MB 34T
Maltepe
Edirnekapı
Adnan Menderes
Halıcıoğlu
Ökmeydanı
Bandıracezp
Ökmeydanı Hastane
Çağlayan
Mecidiyeköy
MB 34
MB 34Z
Zincirlikuyu
Boğaziçi Köprüsü
Sarıhanlıye Mahallesi
Altunizade
Acıbadem
Uzunçayır
Fikirtepe
Söğütlüçeşme
MB 34A
MB 34G
MB 34Z

20
Küçükçekmece
ONE-TO-MANY

33
Atatürk Havalimanı
MANY-TO-MANY (AIRPORT)

29
15 Temmuz Şehitler Köprüsü
ONE-TO-MANY & MANY-TO-MANY

BRT CRASHES: VEHICLE ENTRY INTO ROAD

Kadıköy accident is the lone outlier, which was a cement truck crashing into BRT road barriers.

DURAK	1	8	13	17	22	Total
Atakoy	1					1
Bahçelievler					1	1
Cevizlibağ Sefaköy	1					1
Incirli	1					1
Kadıköy		1				1
Küçükçekmece Sefaköy			1			1
Merter				1		1
Total	**2**	**1**	**1**	**1**	**1**	**7**

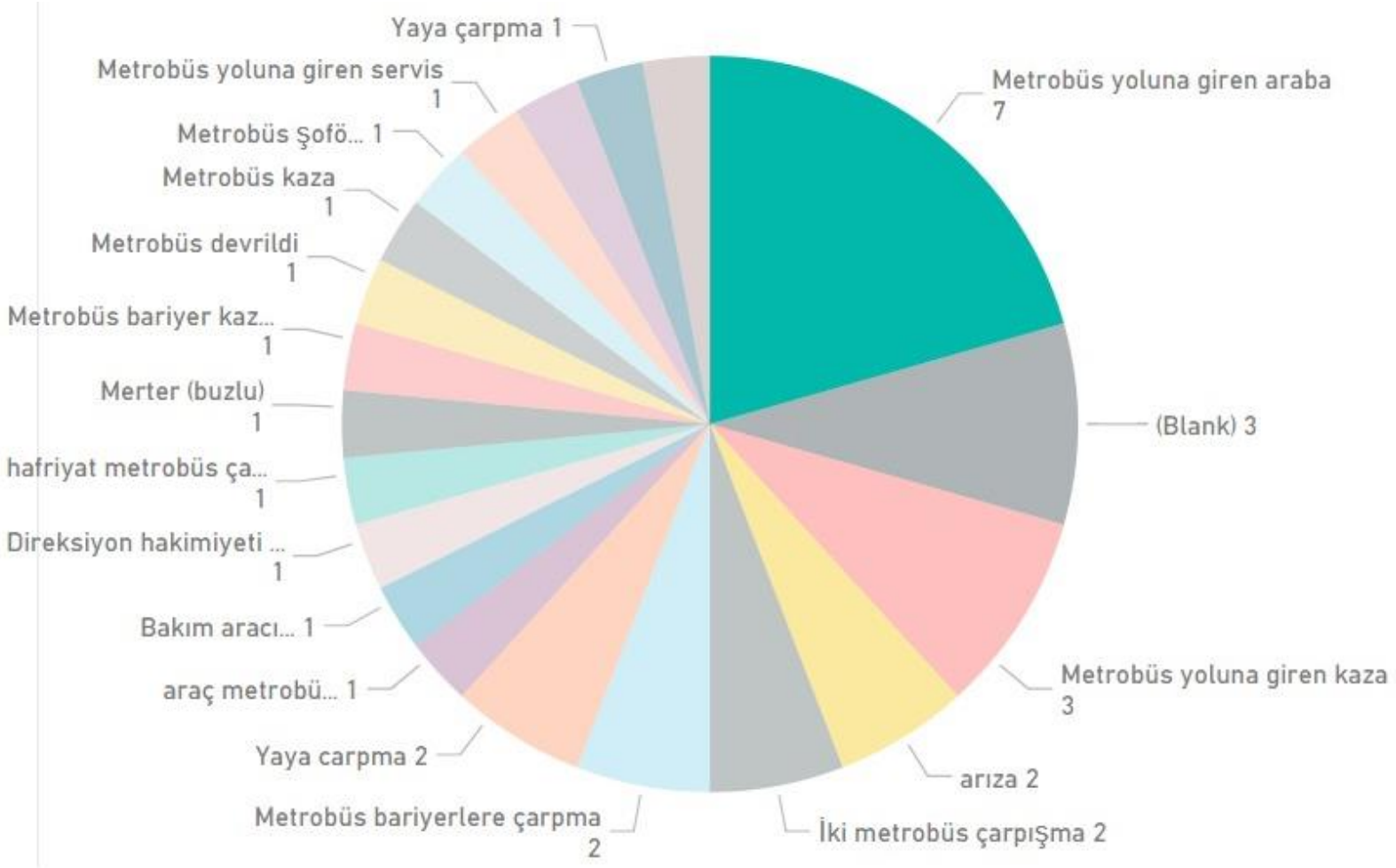


Image 1, 2 – Twitter Search Results for Istanbul Metrobus Line Accidents, 2017

MANY-TO-MANY: FRIDAY EVENING CRASHES

İncirli lies within Merter-Sefaköy section of D100 roadway. In the 3 month dataset, Friday evening crashes concentrated in D100 İncirli, almost as dense as the rest of the city roads combined.

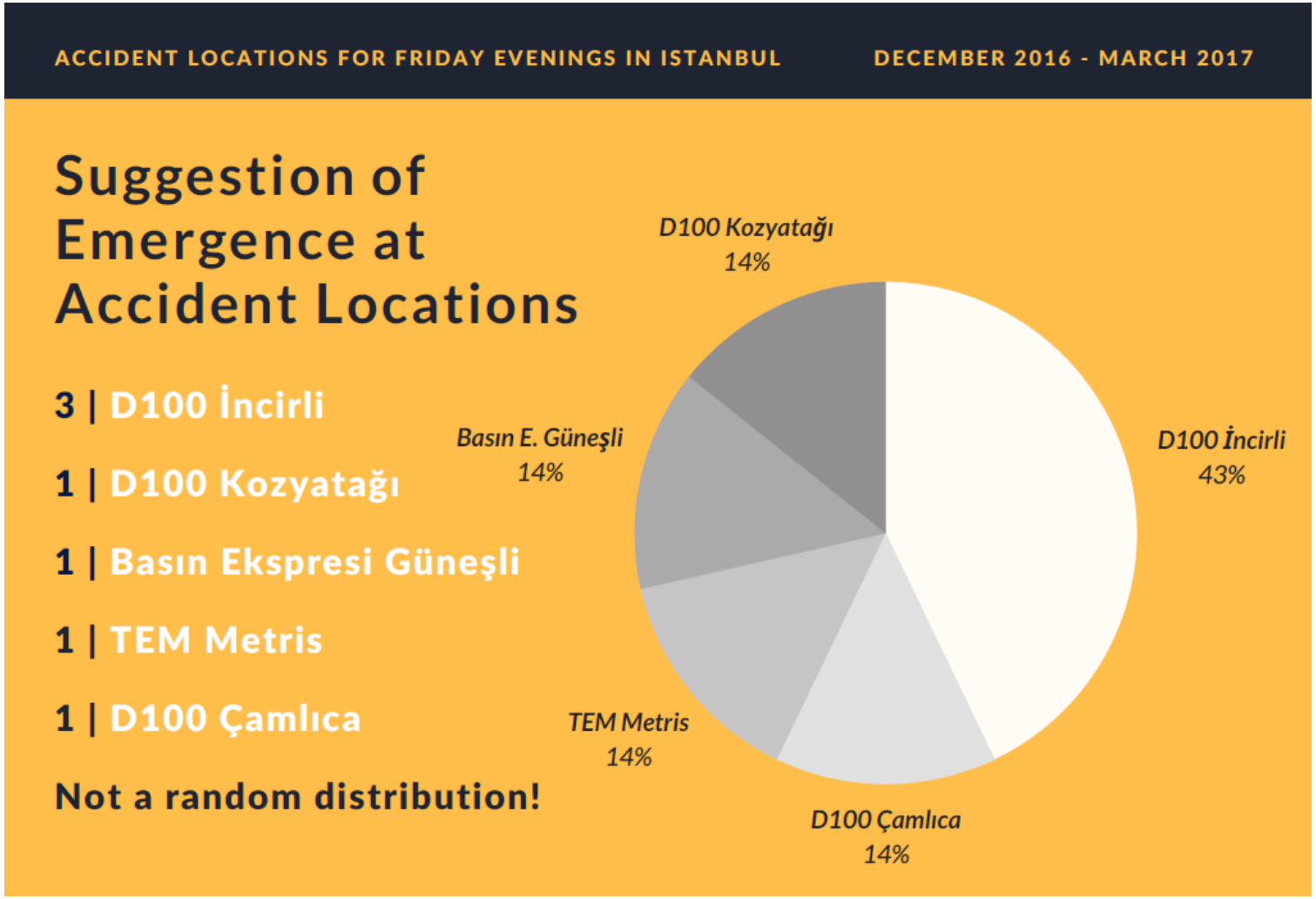


Image 1 – Istanbul Municipality Transportation Management Center Twitter Announcement, Twitter API, December 2016 - March 2017

ITS SUMMIT 2019 *ANKARA, TURKEY*

Association of Intelligent Transportation Systems

ORAL PRESENTATION[1]

1 - http://www.ausder.org.tr/wp-content/uploads/2019/03/Draft_Agenda_7.0.pdf

CRASHES: PRODUCT OF AIRPORT DEMAND

D100 İNCİRLİ PRE-DECOMMISSIONING CRASHES AND CONGESTION ALERTS

Three weeks before:

29 traffic congestion alerts

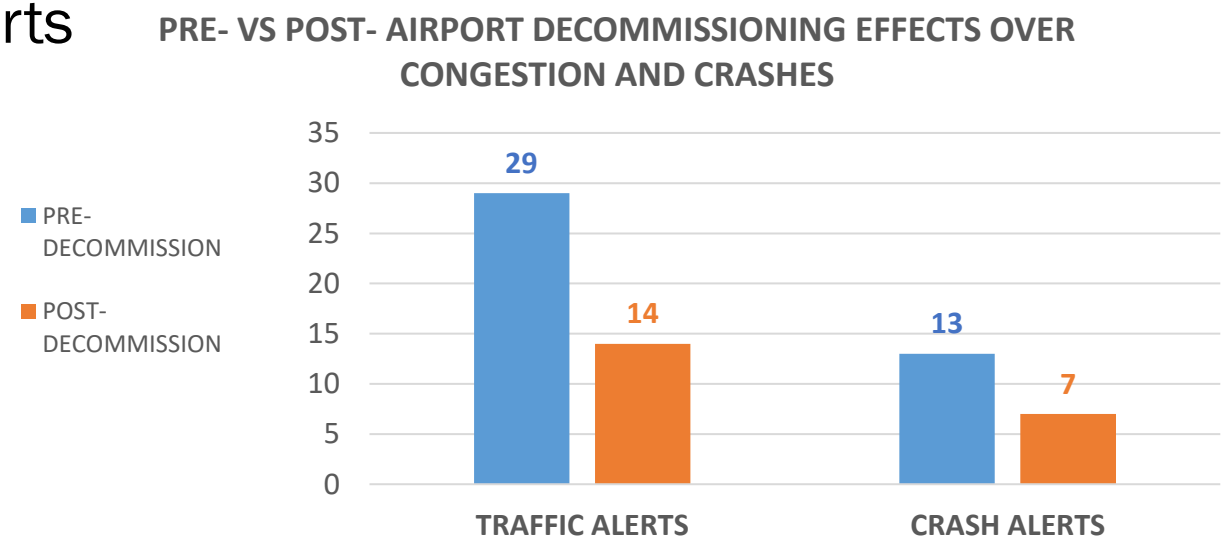
13 crash alerts

D100 İNCİRLİ POST-DECOMMISSIONING CRASHES AND CONGESTION ALERTS

Three weeks after:

14 traffic congestion alerts (**-52%**)

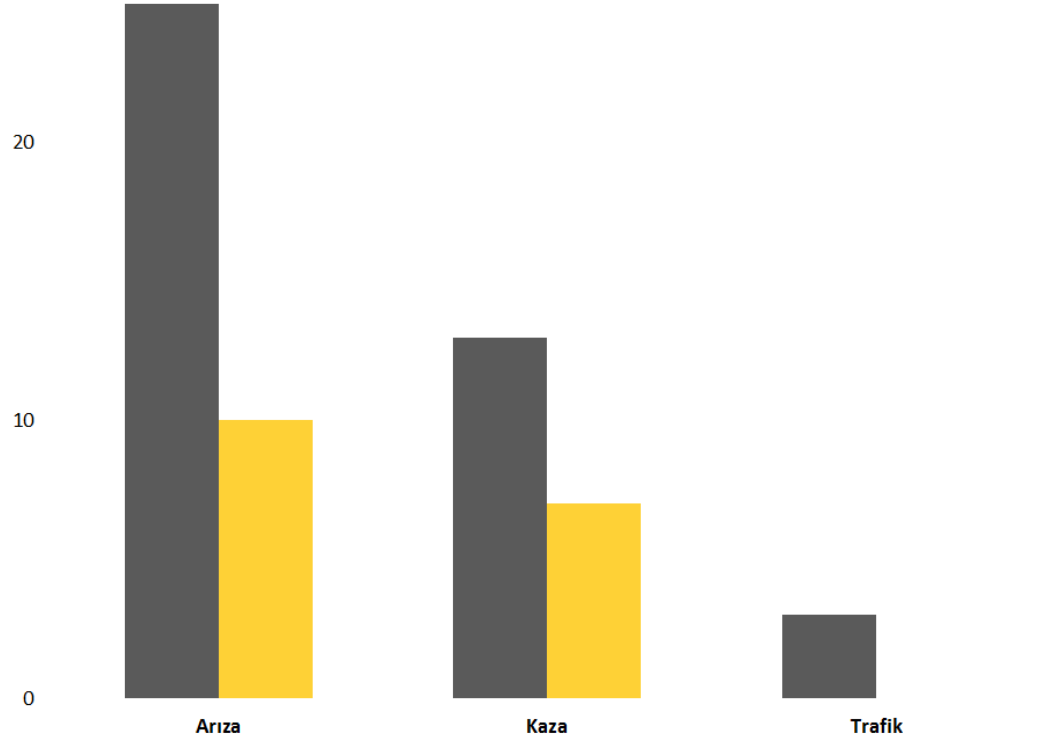
7 crash alerts (**-46%**)



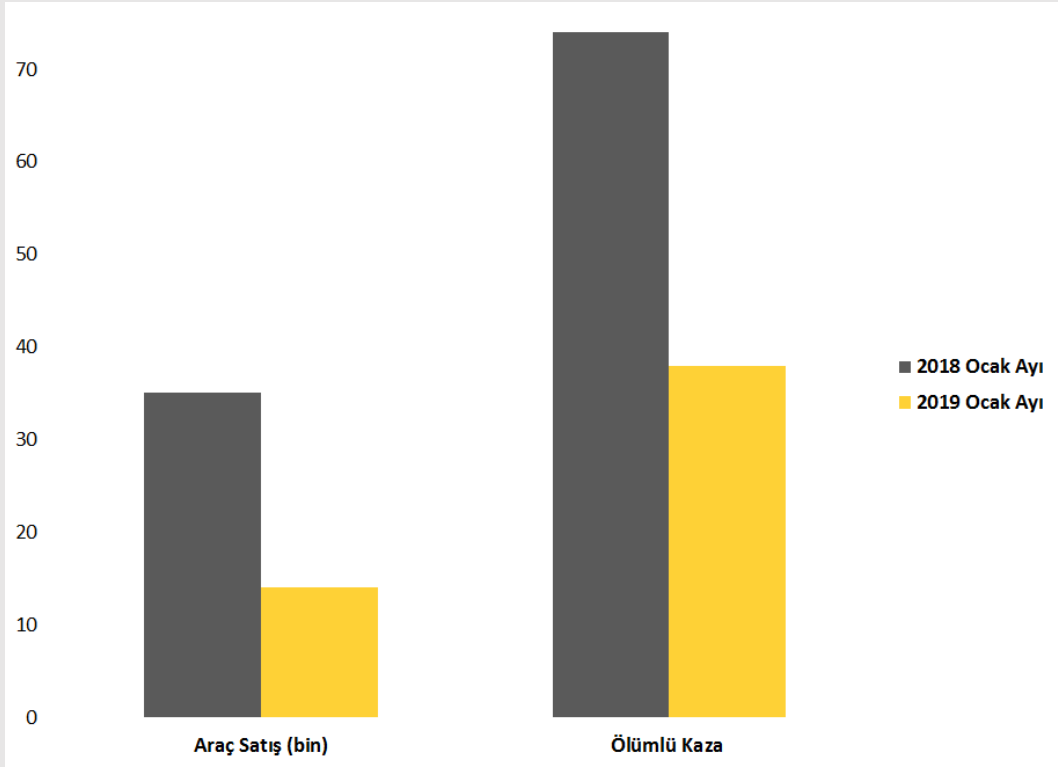
Alerts – Istanbul Municipality Transportation Management Center Twitter Announcement, Twitter Search, March 2019 - April 2019

DEMAND-CRASHES: LINEAR RELATIONSHIP

2018-19 JANUARY VEHICLE SALES DROPS IN CRASHES AND BREAKDOWNS



2018-2019 JANUARY VEHICLE SALES DROPS IN SALES AND FATALITIES

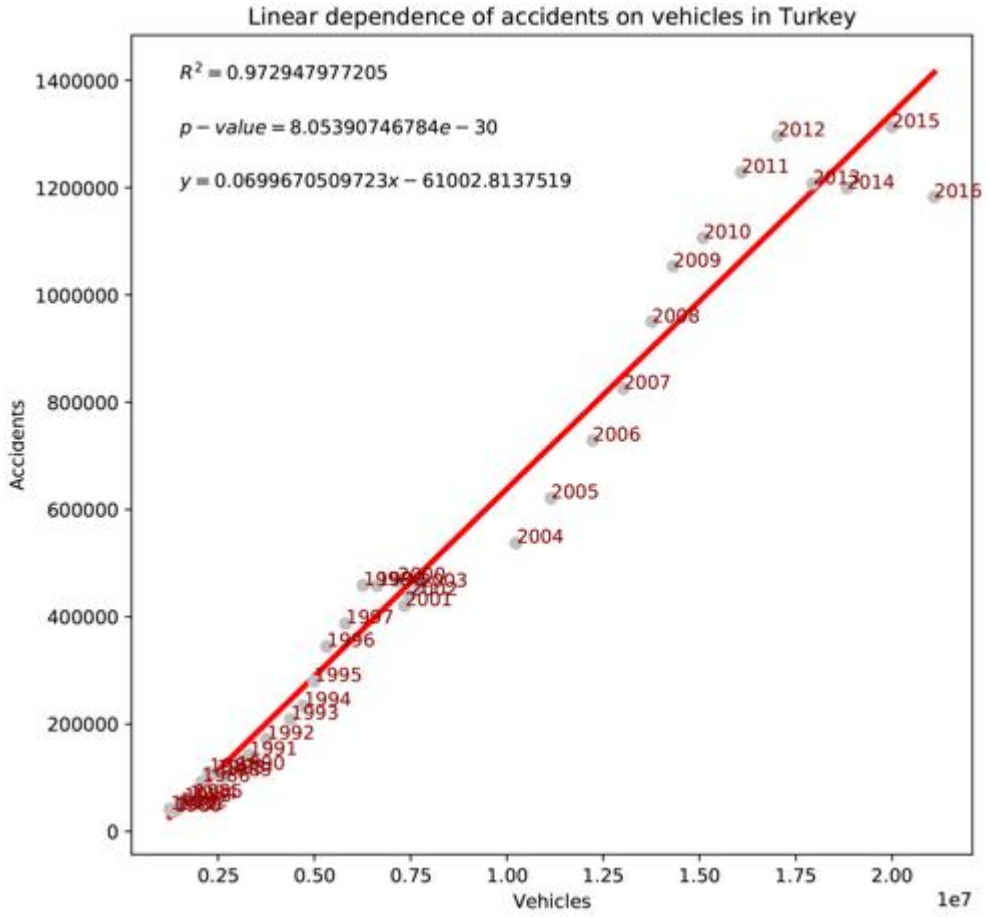


Alerts – Istanbul Municipality Transportation Management Center Twitter Announcement, Twitter Search, January 2018; January 2019
Drops in Automobile Sales in January 2019 - https://alemicihan.com/post/182556630096/2019-ocak-ayi-otomobil-satislarinda-buyuk-dusus-yasandi

VEHICLES VS CRASHES: TURKEY GRAPH

As registered vehicles have risen annually in Turkey, crashes have also risen proportionally. The 0.97 R^2 value is the indicator of this linearity.

However, there is also an expanding spiral that shows there is an additional property beyond linearity.



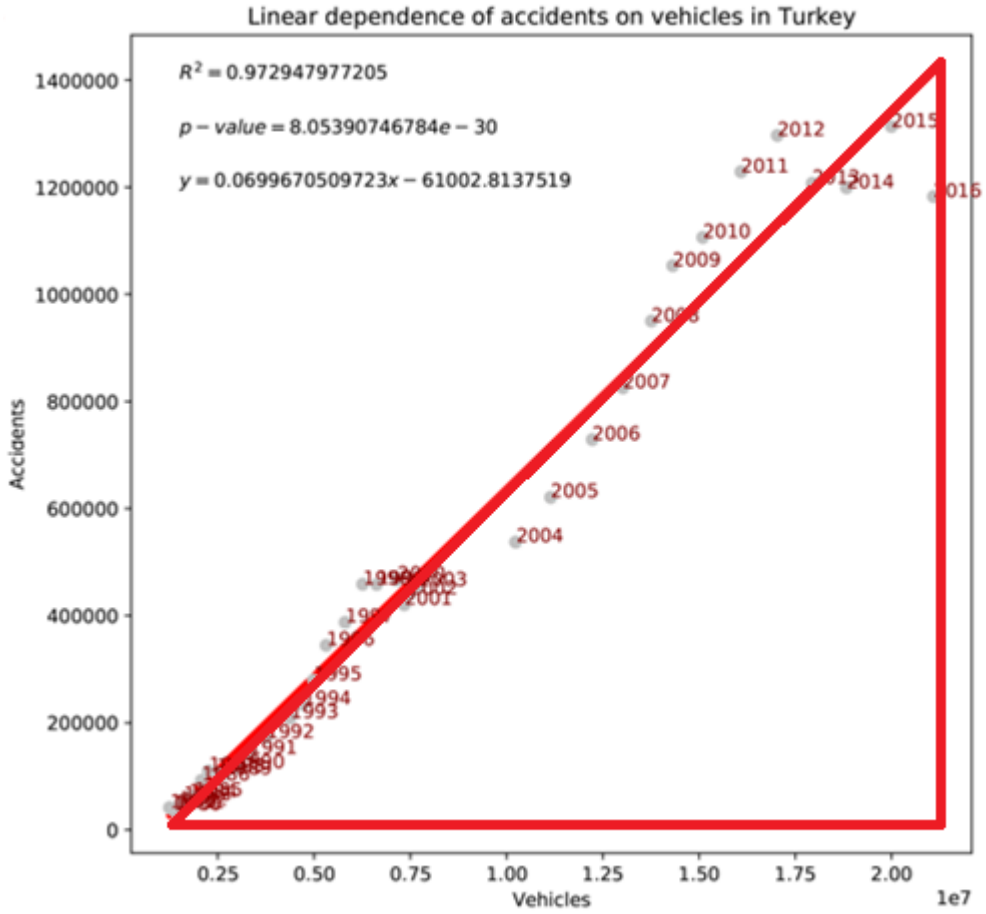
Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1988 - 2016

ONE-TO-MANY CRASHES: TURKEY GRAPH

LINEAR CRASHES

More vehicles causing more crashes is a counterintuitive property of traffic flow. More vehicles should lead to congestion, which should decrease crashes. Yet, as explained before, the opposite is the case.

One-to-many corresponds with linearity. Early morning crashes at bottlenecks is a clear indicator of heavy traffic demand.



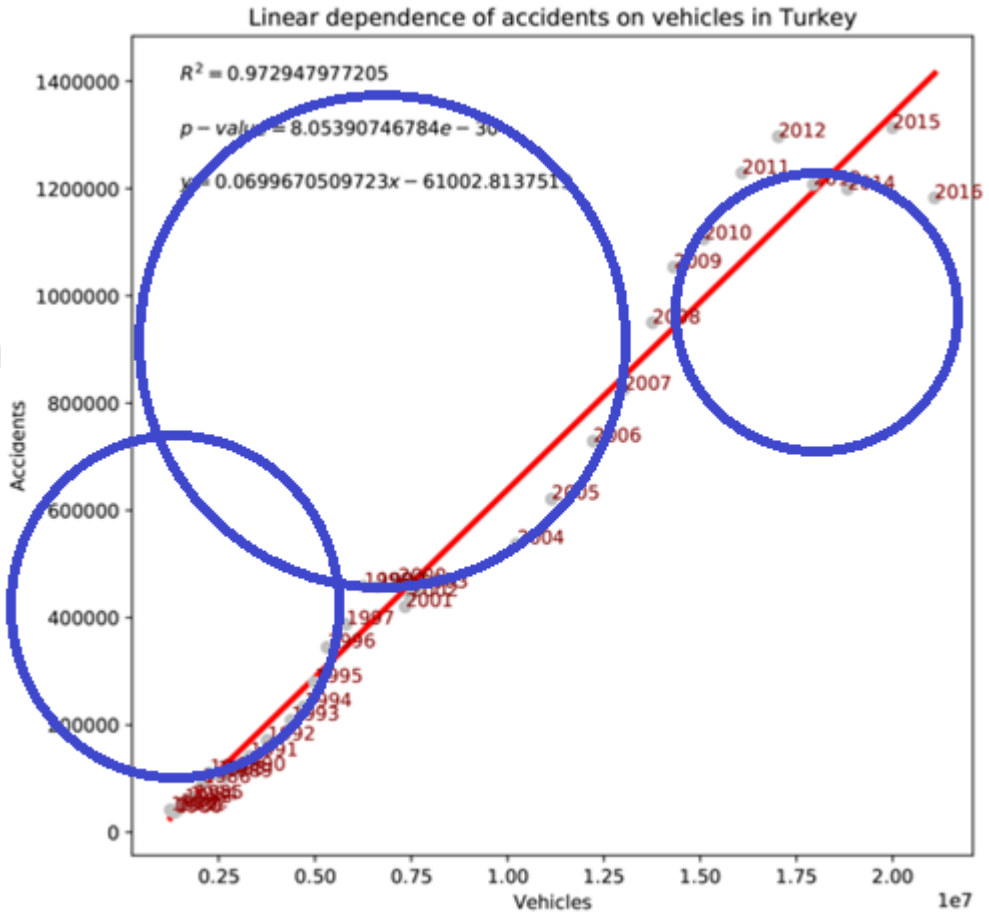
Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1988 - 2016

MANY-TO-MANY CRASHES: TURKEY GRAPH

NONLINEAR CRASHES

The spiraling distribution of accidents is not very easy to quantifiably explain. Although certain economic downturns can be pinpointed (2001 economic crisis), the overall behavior of the graph is at the first glance not clearly visible.

To capture the driving force, a breakdown will be applied on city and vehicle scales.



Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1988 - 2016

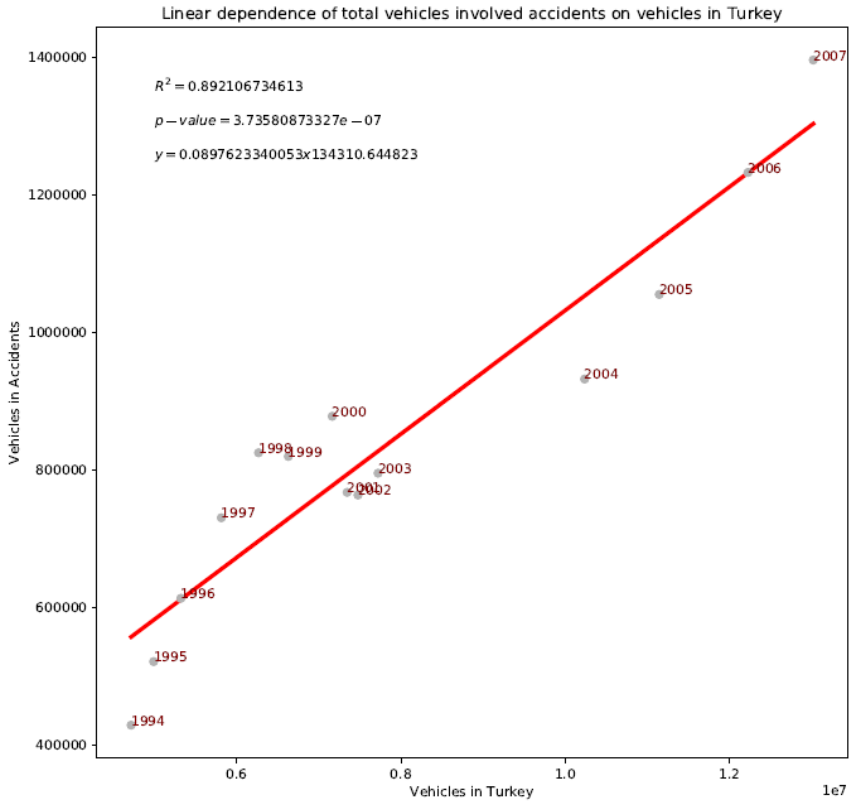
NONLINEAR CRASHES: VEHICLE TYPE

CITY AND VEHICLE SCALE DOWN

Turkish Statistical Institute's crash data per vehicle type and city is limited to 1994-2007. For total crashes, graph on the right is given.

I have first scaled down crashes by municipal metropolitan cities, then by vehicle types.

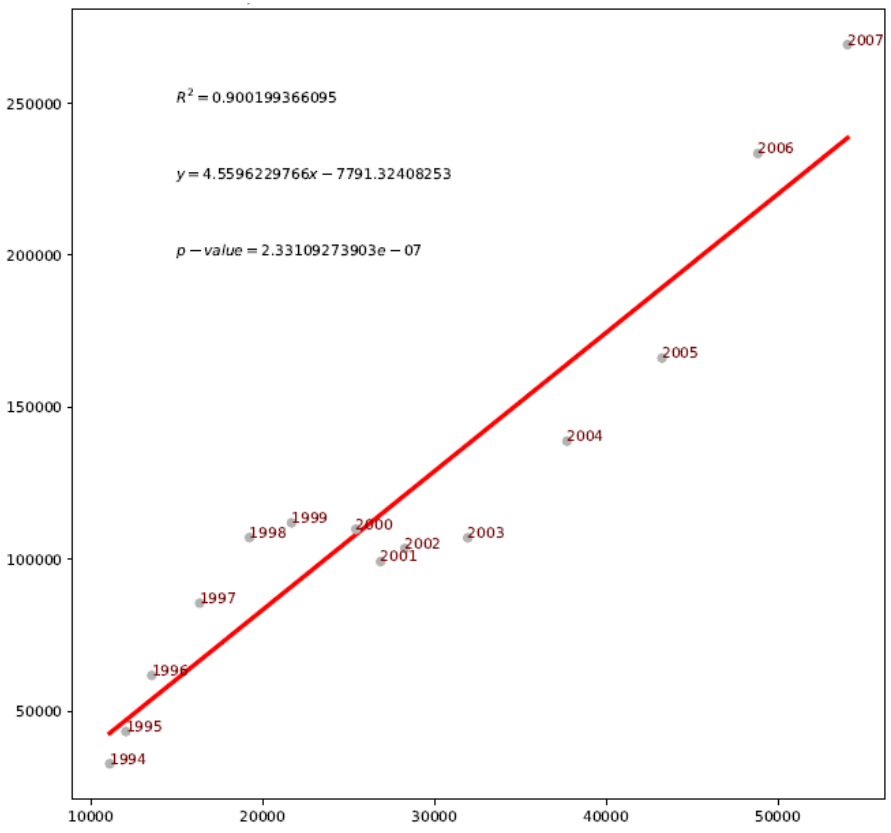
Only vehicle type to maintain this symmetry must be the driving force behind crashes.



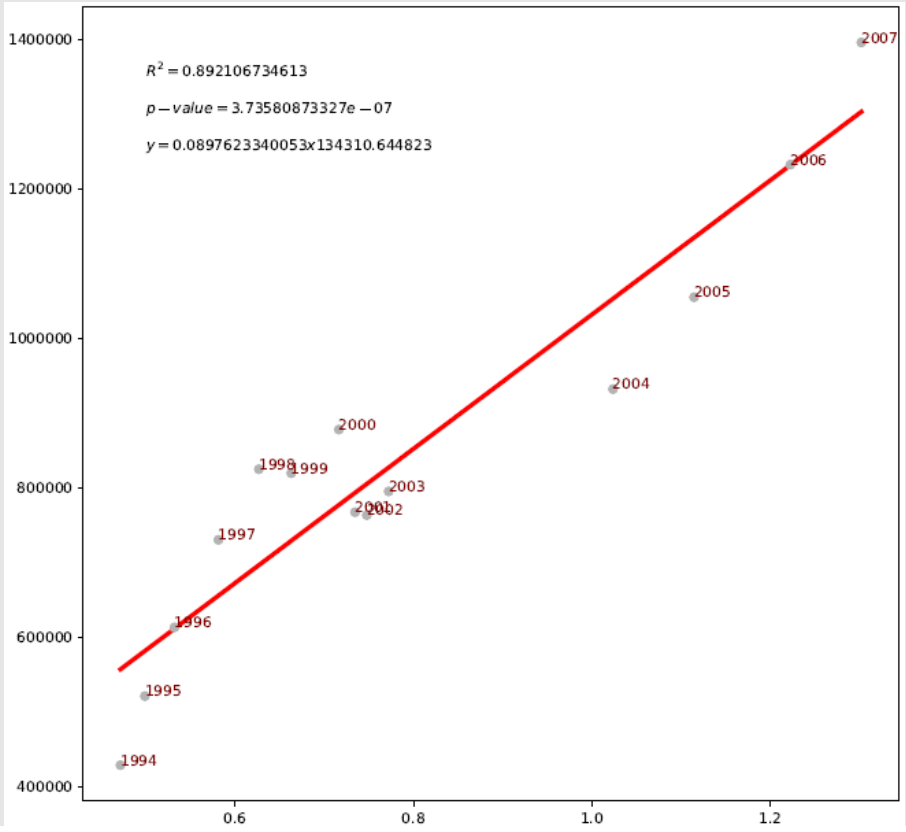
Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1994 - 2007

EMERGENCE: LIGHT TRUCKS / LCVs

LCV SYMMETRY IN ADANA



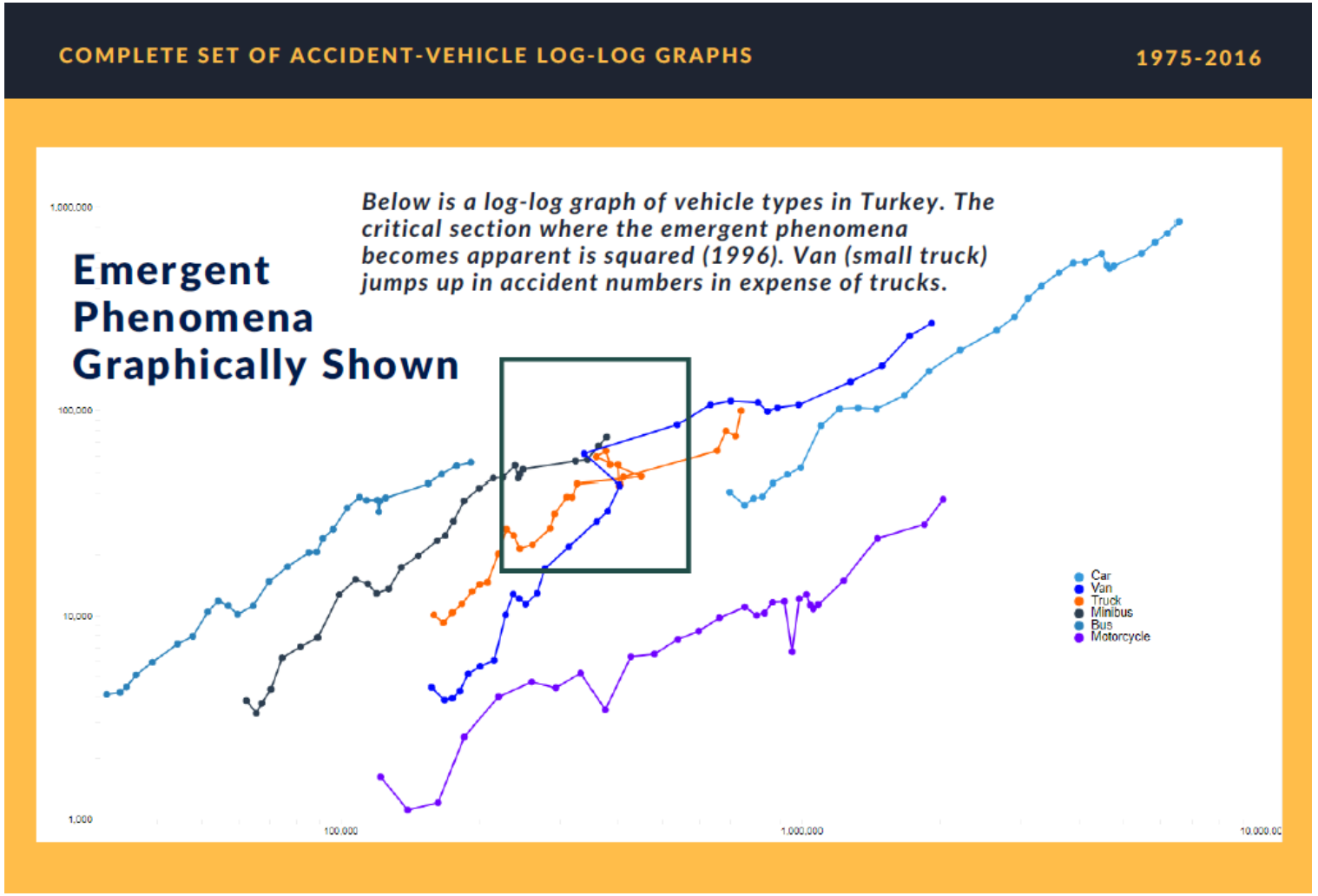
TOTAL VEHICLES SYMMETRY IN TURKEY



Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1994 - 2007

CRASH WEIGHT: LCVs INCREASING

On the log-log graph of all vehicle types in Turkey, vans (LCVs) appear to take over the trucks in the year 1996. This is in fact in the narrow streets of Turkish cities, LCVs are more maneuverable and better suited for the SME dominant Turkish market.



Data: Turkish Statistical Institute (TÜİK) - Annual Traffic Crash Report, 1994 - 2007

CURRENCY CRISIS: CAR IMPORTS HALT

CURRENCY CRISIS OF TURKEY

USD/TRY parity skyrocketed from 2.8 in 2016, to 8.1 in 2021, called **2018 Turkish currency and debt crisis**[1]. Majority of vehicles are imports, and the currency rates crashed sales in 2018 and 2019.

TURKISH LIRA CRASH: DROP IN VEHICLE SALES 2018-2019

2016	1.214.610
2017	1.247.449
2018	903.274
2019	671.131
2020	1.038.905

2020: Government stimulus packages

METRO ISTANBUL NEW LINES: SURGE TO PUBLIC TRANSIT IN 2018 AND 2019

TOTAL DAILY TRANSIT RIDES:

2017: 12,939,000[2]

2018: 13,898,470[3] **+7%**

2019: 15,148,333[4] **+9%**

2020 not included due to pandemic lockdowns and travel restrictions.

More Istanbulites turned to public transit as their primary mode for commute.

Image 1: Turkish Statistical Institute (TÜİK) Biruni Central Distribution System https://biruni.tuik.gov.tr/

1 - https://en.wikipedia.org/wiki/2018_Turkish_currency_and_debt_crisis

2 - https://www.gzt.com/jurnalist/istanbulda-toplu-tasimanin-sayisal-verileri-2798866

3 - https://www.ibb.istanbul/News/Detail/36320

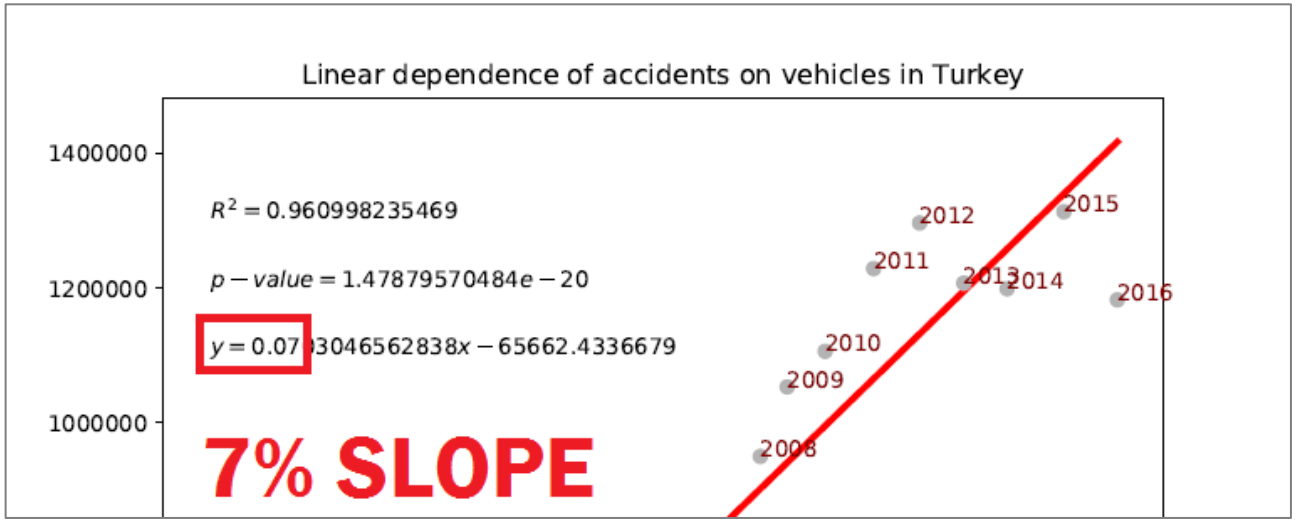
4 - https://www.iett.istanbul/tr/main/pages/istanbulda-toplu-ulasim/95

UNIVERSALITY: LADDERING OF SCALES

7% CRITICAL SYMMETRY

7% HEAVY VEHICLES IN D100 İNCİRLİ

7% HOURLY TRAFFIC IN D100 İNCİRLİ



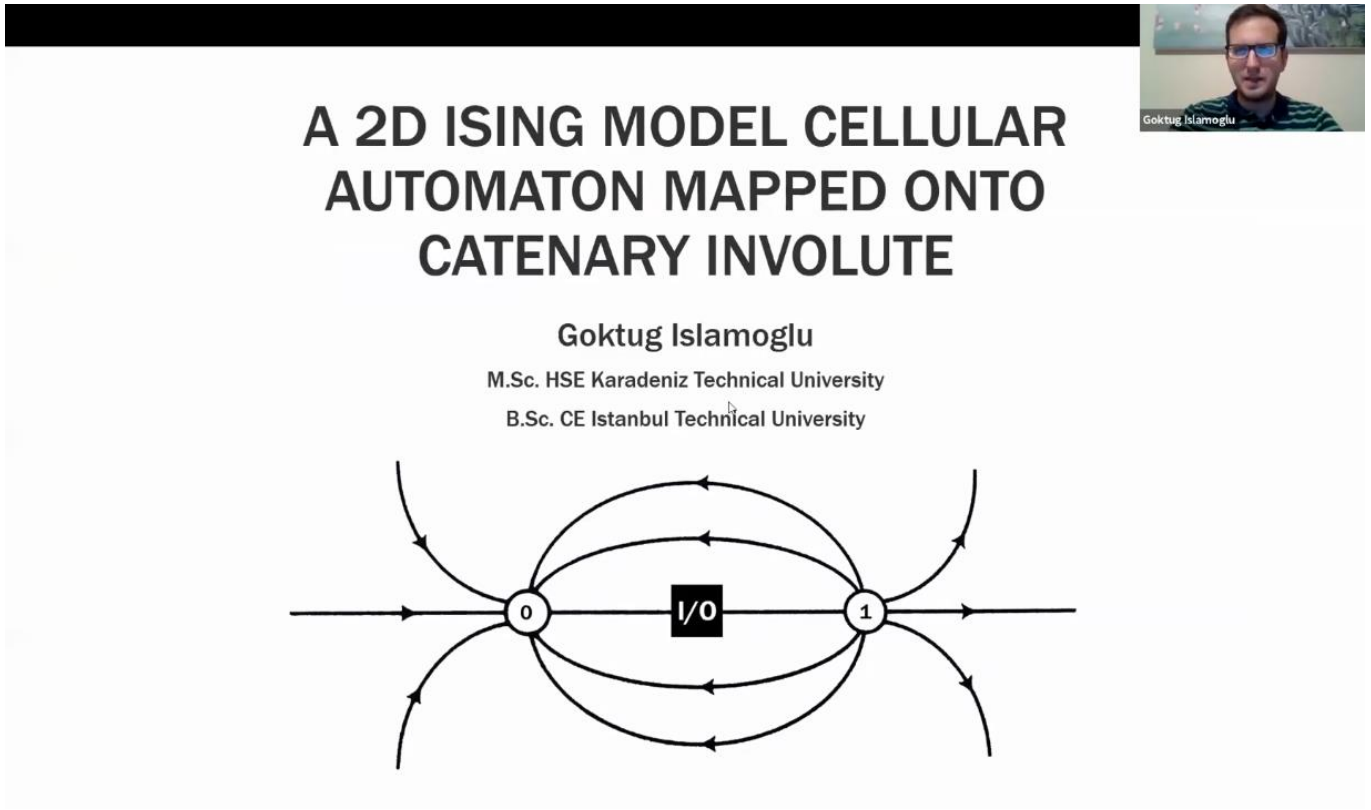
Sales dictate on macro scale, black spots on micro. Critical micro-macro laddering is: **scale-free behavior**

Universality: The emergence of 7% in the **crash-vehicle graph's slope**, the **many-to-many black spot heavy vehicles distribution** and its **hourly traffic ratio** is a universal pattern.

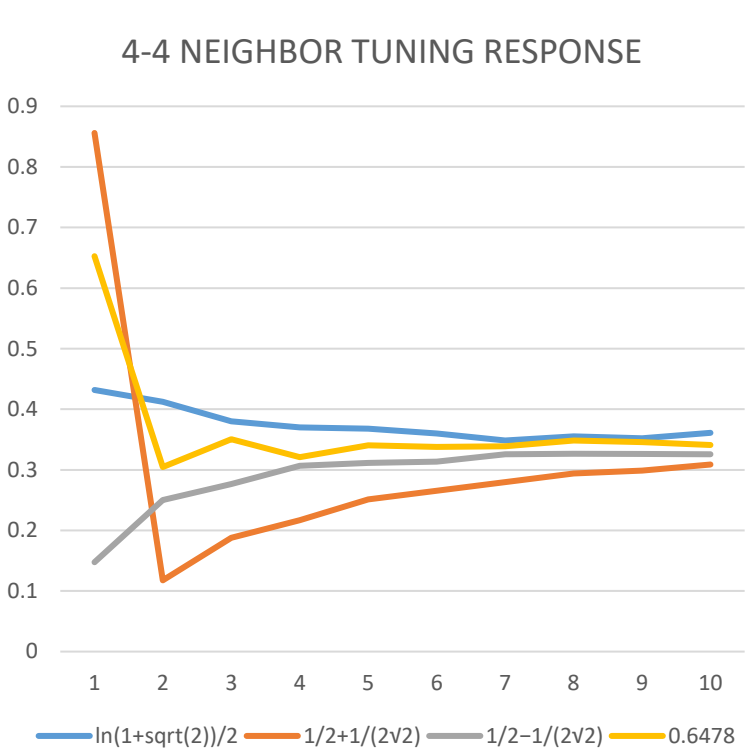
ICCS 2020 *ONLINE, NECSI*

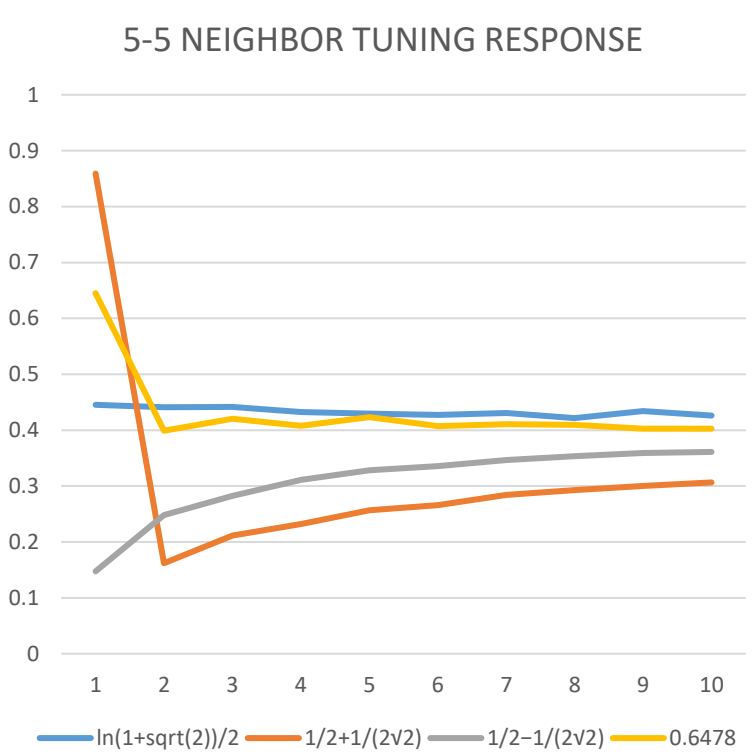
Tenth International Conference on Complex Systems

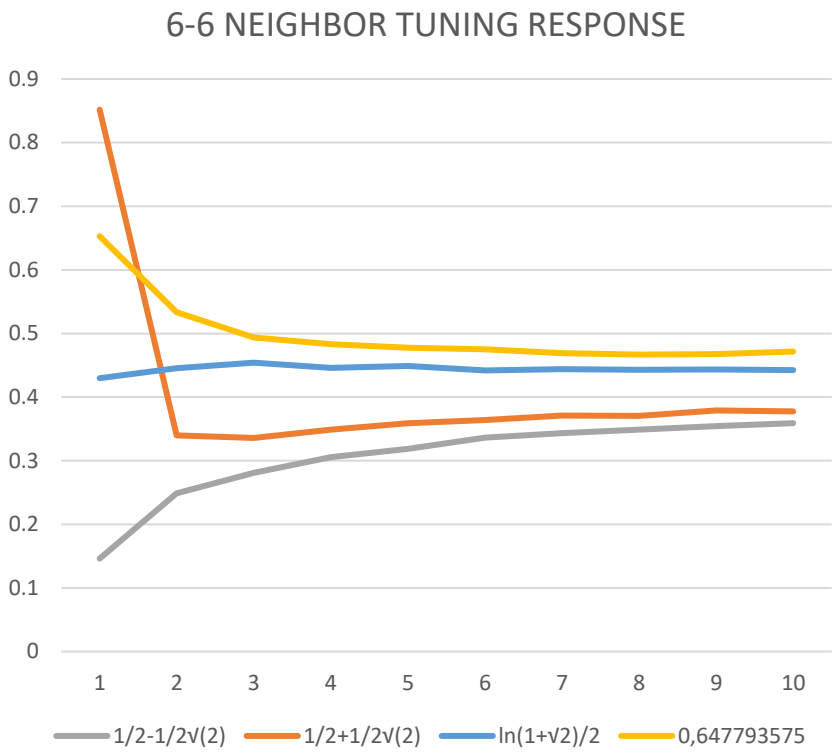
ABSTRACT PRESENTATION



NEIGHBORHOOD: ISING VS FERROMAGNETIC



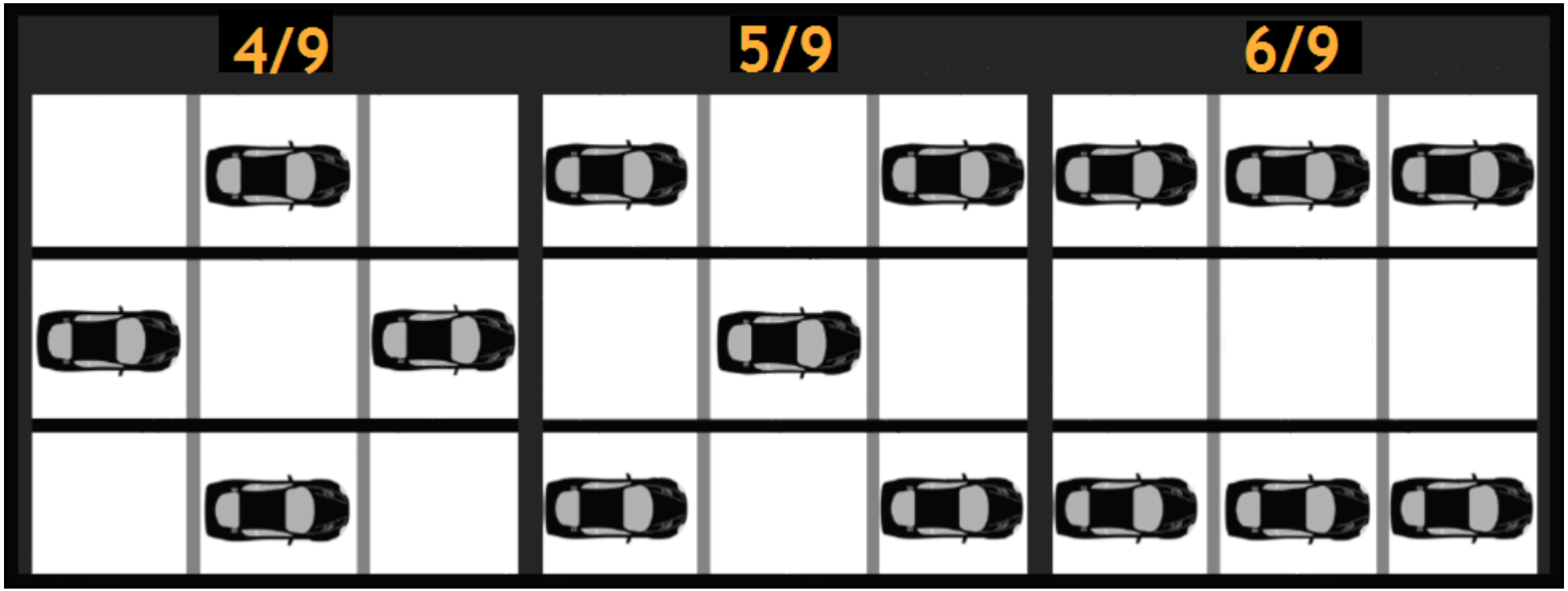




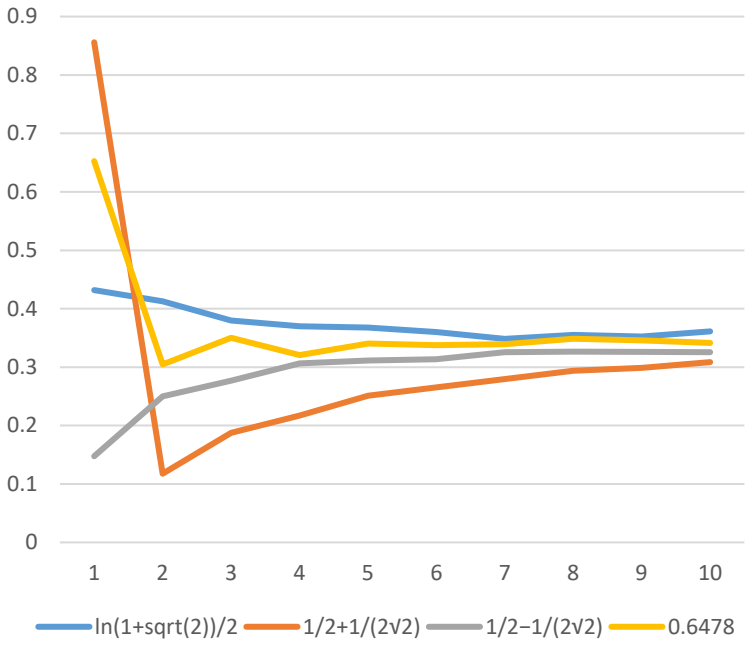
Tuning for 4 and 5 neighbors has Inverse Ising critical temperature as the highest state 1 cell count.

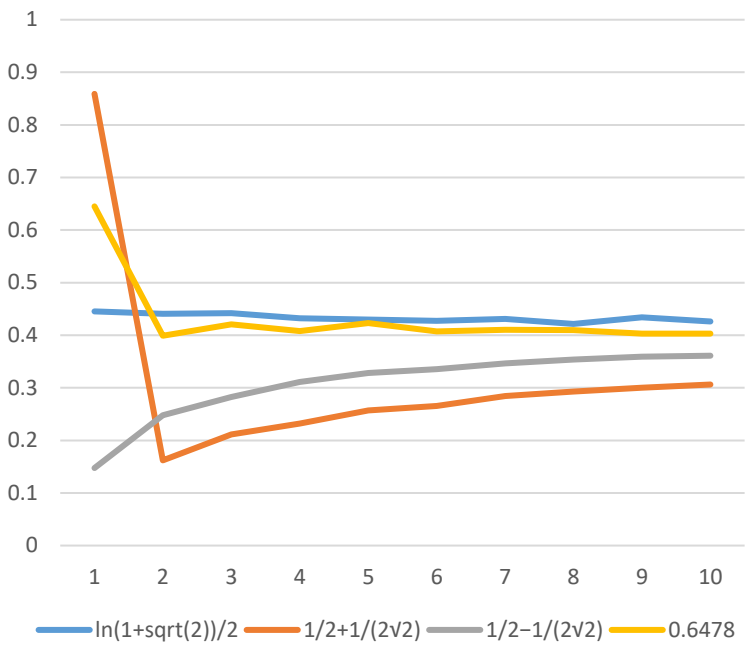
For 6 neighbors however, there is another maximum susceptibility, corresponding to ferromagnetism.

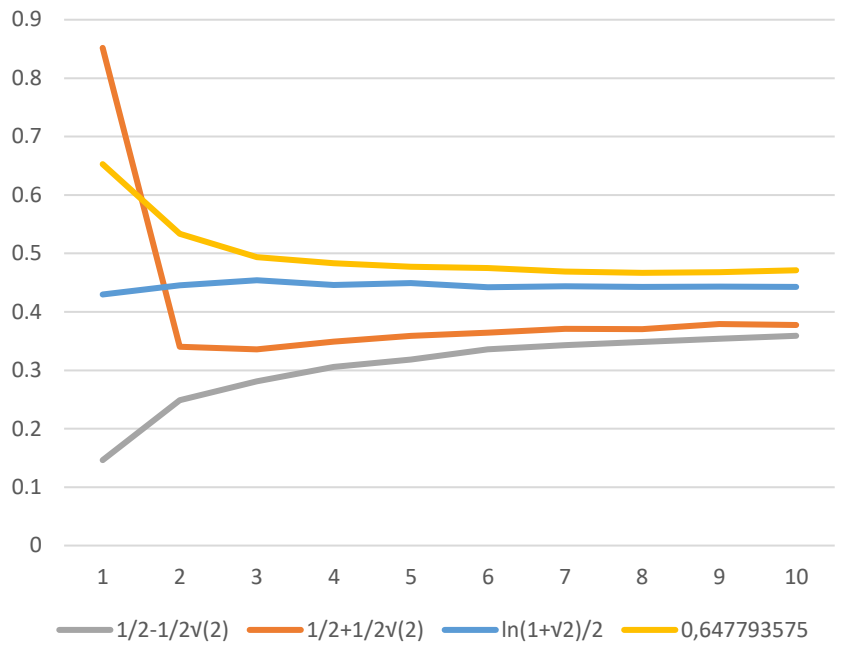
NEIGHBORHOOD: MAGNETIZED TRAFFIC

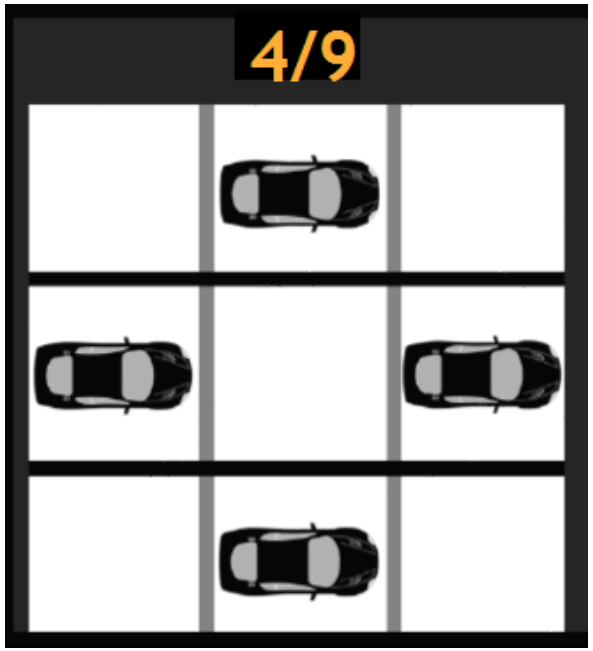


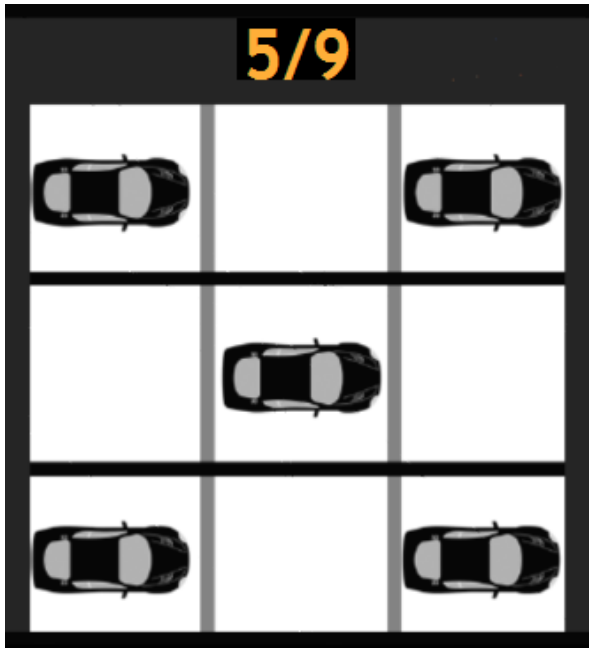
PARAMAGNETIC PARAMAGNETIC FERROMAGNETIC


4-4 NEIGHBOR TUNING RESPONSE
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10
ln(1+sqrt(2))/2
1/2+1/(2√2)
1/2−1/(2√2)
0.6478


5-5 NEIGHBOR TUNING RESPONSE
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10
ln(1+sqrt(2))/2
1/2+1/(2√2)
1/2−1/(2√2)
0.6478

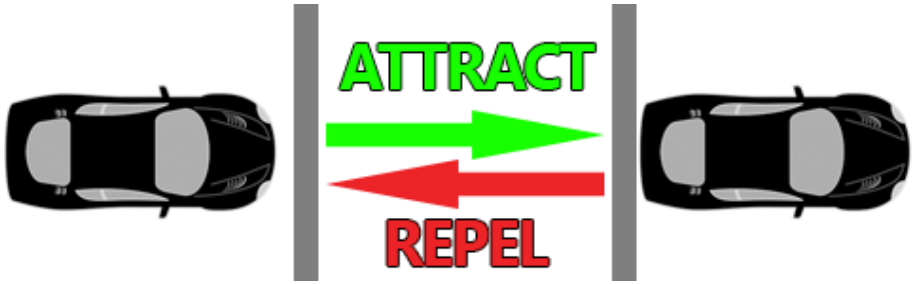

6-6 NEIGHBOR TUNING RESPONSE
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10
1/2-1/2√(2)
1/2+1/2√(2)
ln(1+√2)/2
0,647793575

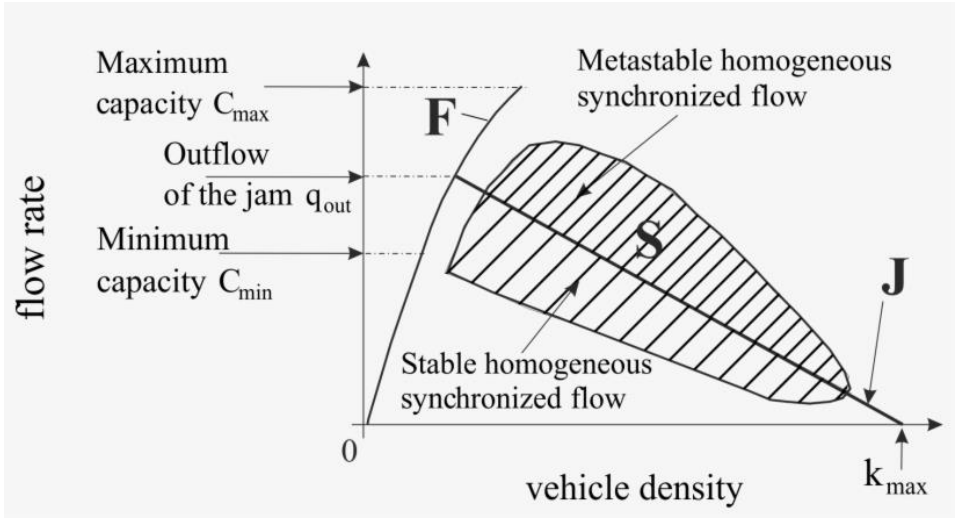

4/9


5/9


6/9

TRAFFIC: UNIAXIAL ATTRACTION-REPULSION





A tailing car is attracted to a frontal car's position, but is forced to leave a trailing distance, a repulsion.

We suggest that this attraction-repulsion is a dipole in the driving direction, and in the normal direction, there is a non-dipole attraction between the vehicles which manifests as lane merging.

Left Below: Synchronized Traffic Flow-Density Graph (Boris Kerner)

ANALOG MODELS: TRAFFIC AND STEEL BARS

https://github.com/goektug/Equation-Automata