Analysis of Queues and Level of Service on Urban Roads Using Machine Learning and NoSQL Database

(Master thesis work)

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Motivation

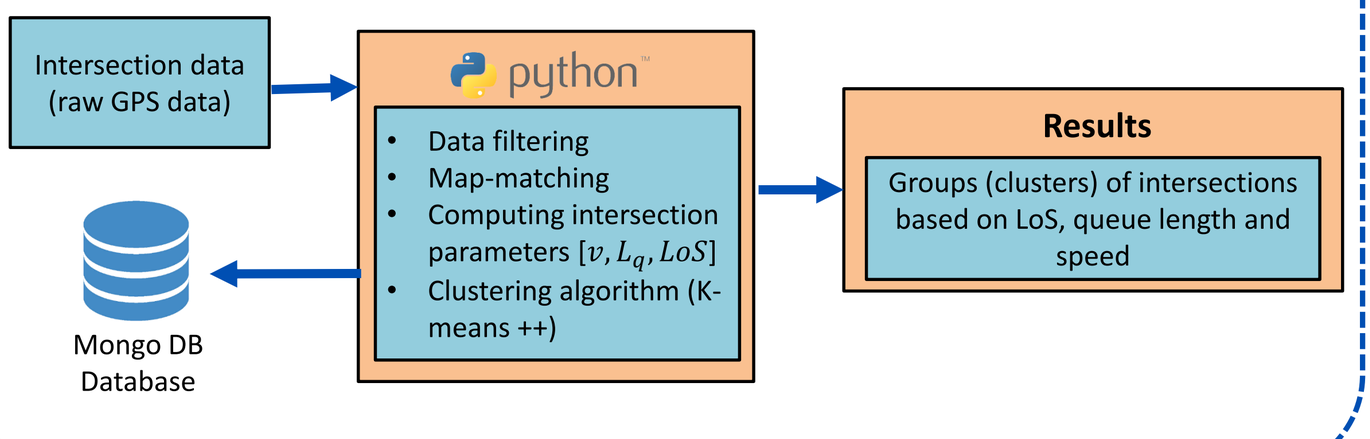
Traffic congestions appear mostly in urban areas, at intersections. Therefore, it is important to have a measure to quantify intersection performance, especially during rush hours. Usually, intersection's Level of Service (LoS) is used as a performance measure in project design.

Raw GPS data are used to calculate characteristic parameters for every intersection:

- Speed (v)
- Queue length (L_q)
- Level of Service (LoS)

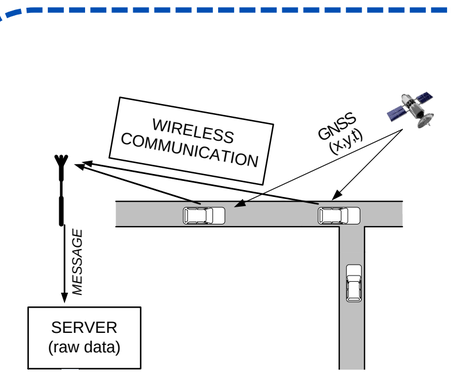
Characteristic vector $[v,\ L_q,\ LoS]$ is formed for every intersection approach and used as input to the machine learning algorithm.

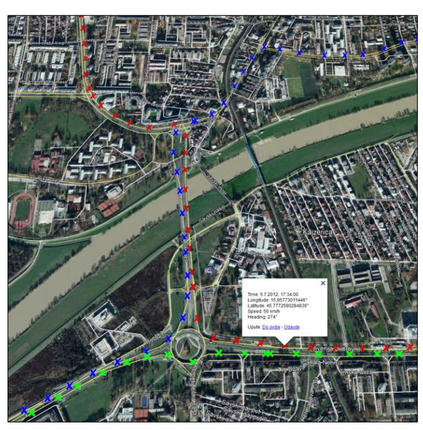
Diagram

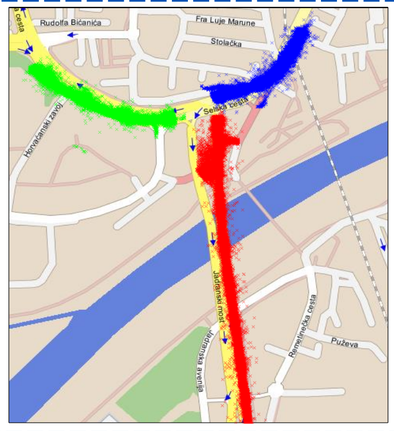


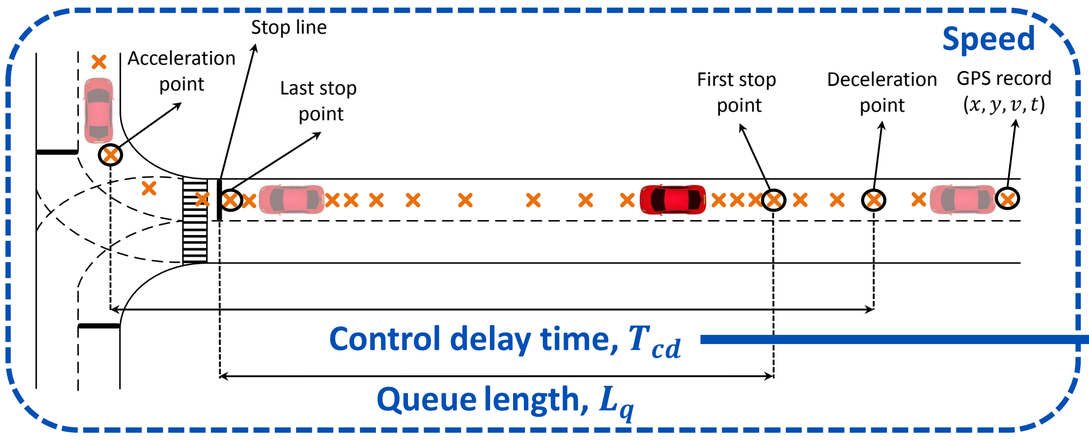
Data & Modeling

- GPS data
  - $2009 - 2014$
  - 4200 vehicles
  - Provided by Mireo Inc., as a part of SORDITO project
  - Each record contains
    - Time-stamp
    - Longitude
    - Latitude
    - Speed
    - Heading
    - GPS status
    - Satellites









Level of Service, LoS

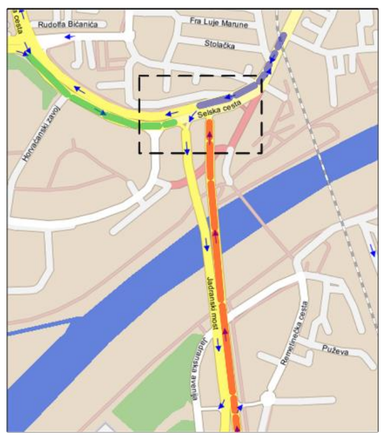
- Highway Capacity Manual (HCM, 2010)

Control delay [s]	LoS	Description
≤ 10	A	free-flow
$\langle 10, 20]$	B	unimpeded operations
$\langle 20, 35]$	C	stable operations
$\langle 35, 55]$	D	unstable operations
$\langle 55, 80]$	E	significant delays
> 80	F	extremely low speeds

Results

Intersection example

Adriatic bridge

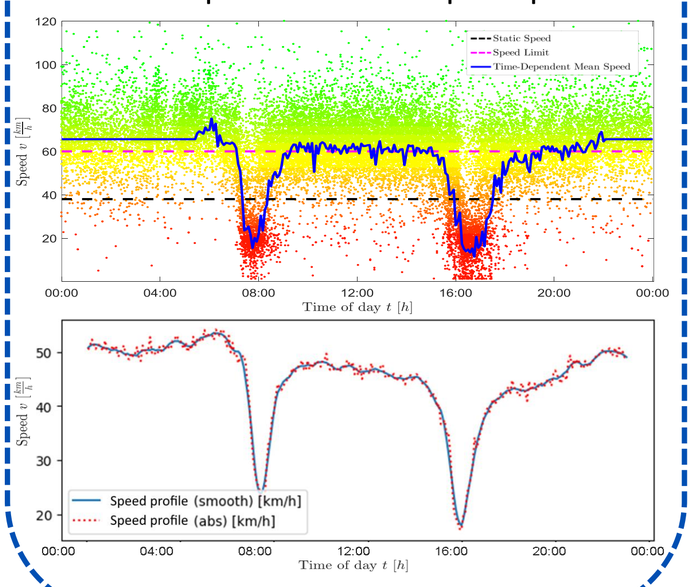


Data

A	GPS data	Routes	Segments
S	1005436	109307	5
N	295373	54261	6
W	262580	41845	4

Speed

Time-dependent mean speed profile

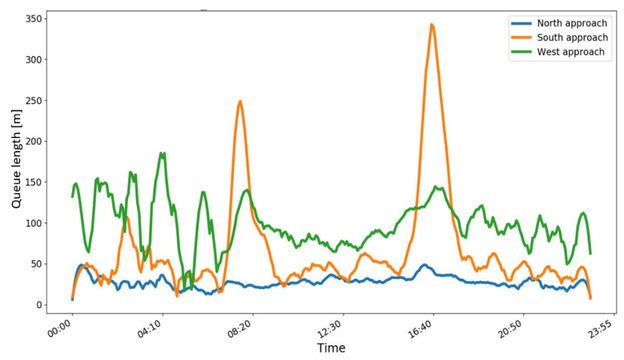


Control delay and LoS

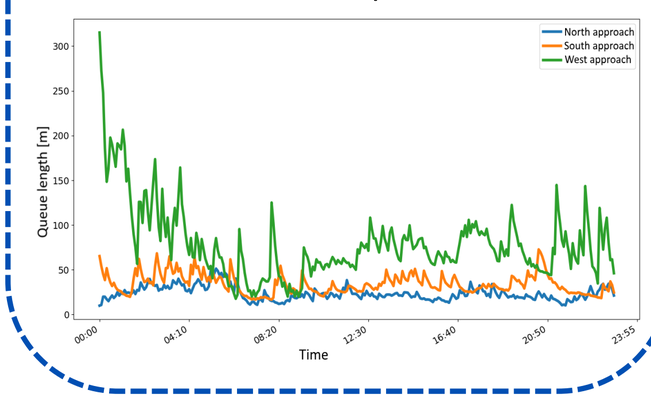
A	Whole day		Rush hours		Non-rush hours	
	t_{cd}	LoS	t_{cd}	LoS	t_{cd}	LoS
N	44.82	D	49.40	D	34.30	C
S	50.89	D	70.07	E	34.27	C
W	67.93	E	78.77	E	48.36	D

Queue length

Work-day profile

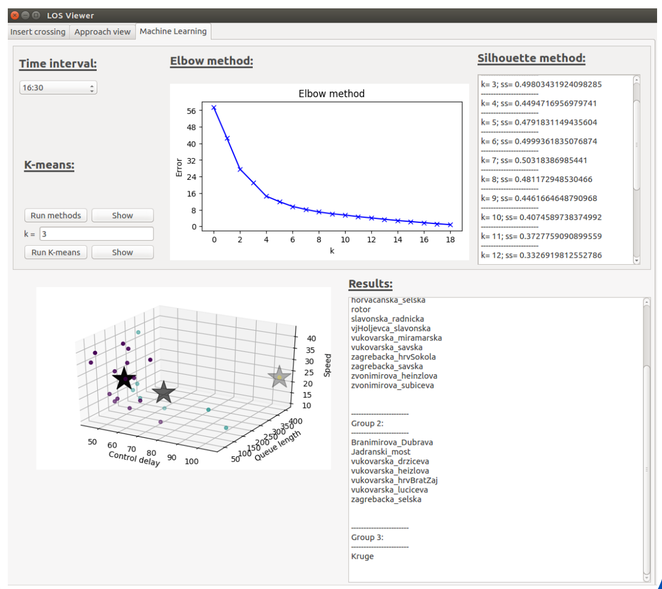


Weekend profile



Clustering

- 23 most relevant intersections in City of Zagreb
- K-means++ algorithm
- Intersections grouped by similar characteristics



Future work

- Using larger data set; widening research to all larger intersections in the City of Zagreb
- More granular approach; detecting intersection approaches with anomalies
- Ground truth values
- Real-time data and adaptation to computing intersection performance

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