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IRF WORLD ROAD MEETING 2017
/ 14-17 NOVEMBER / DELHI / INDIA /

TEMPORAL CLASSIFICATION OF FLOW-PATTERNS IN URBAN ROAD NETWORK

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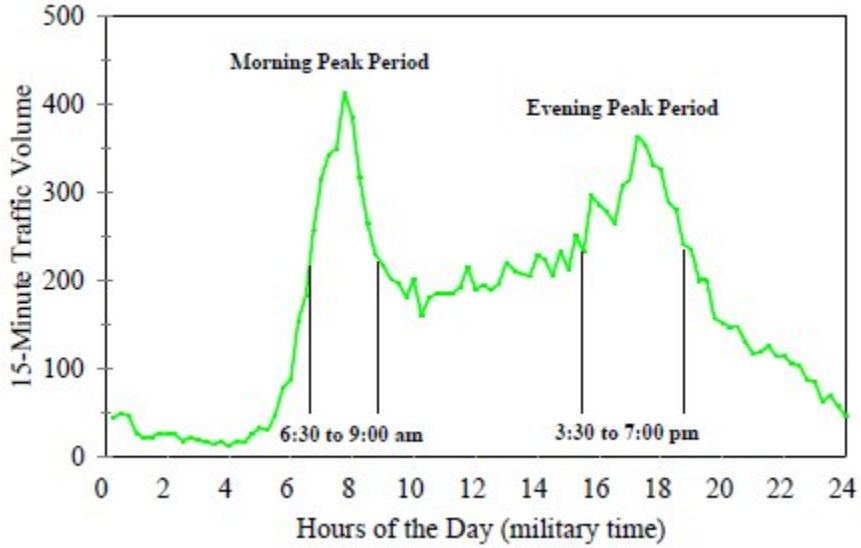
BACKGROUND

Flow Patterns

- Traffic flow is Temporal in Nature
- Within-day traffic flow variation is classified as peak and off-peak period
- Traditionally determined based on the graphical flow patterns
- Researchers now focus on scientific approaches



Source: FHWA (1998).

OBJECTIVE

To classify the within-day variation in traffic flow by considering inherent temporally continuous nature of traffic flow data

LITERATURE

- Auto Regressive Integrated Moving Average (ARIMA), Nonparametric regression, Neural networks, and Heuristics
- Heuristic search -- Genetic Algorithm (GA) and Artificial Immune Systems (AIS)
  - Hypothetical arterial networks
  - Too many adjustable parameters in the algorithm for which they were found difficult to employ
- **Cluster analysis**
  - Non-hierarchical – **K means**
  - Hierarchical

SMOOTHENING TECHNIQUES

- Traffic flow patterns are often found with irregular short-term variation time series data, which pose a difficulty while creating clusters
- Data smoothening technique → understanding underlying trend, cyclic and seasonal components in a time series data
- **Simple moving average (SMA) technique**

$$X_i' = \frac{X_{i-l} + X_{i-l+1} + \cdots + X_i + \cdots + X_{i+l-1} + X_{i+l}}{l}$$

$\forall i=1,2,3\ldots;\ l=1,2,3\ldots$

X_i' →smoothing average value of a set of l data points taken equally from either side of the original data point X_i

K MEANS CLUSTERING

Consider set of data points
$X = \{x_1, x_2, \dots, x_n\}$

Define c number of cluster centers
$V = \{v_1, v_2, \dots, v_c\}\ \forall c \leq n$

Estimate distance between each data point and cluster centers
$d_{ij}{}^2 = (x_i - v_j)^2$

Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers

Calculate the new cluster center
$v_i{}' = \frac{1}{c_i}\sum_{j=1}^{c_i} x_i$

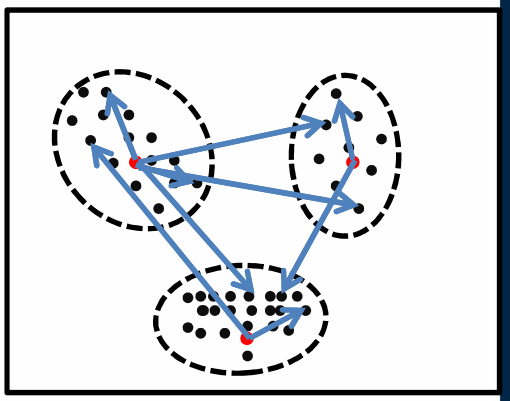
Calculate the distance between each data point and new obtained cluster centers
$d'_{ij}{}^2 = (x_i - v_j')^2$

Estimate change in centroid points

YES

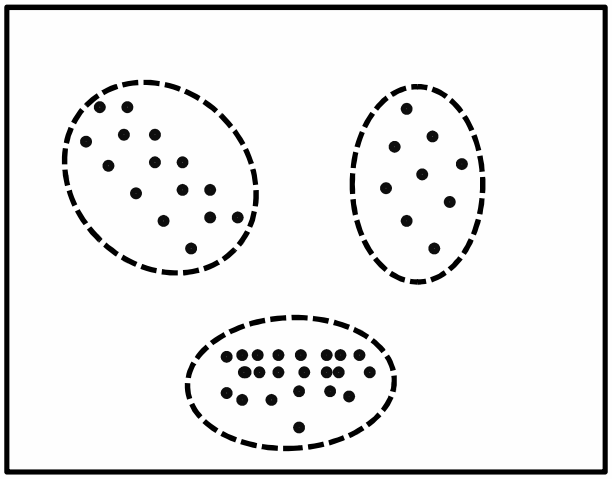
NO

Form final clusters



CLUSTER VALIDATION

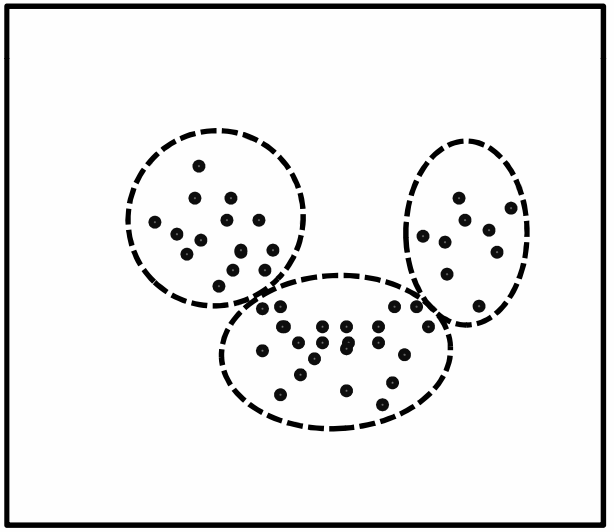
- Check similarity of a set of data points to their own cluster as compared to other clusters



s_i = silhouette coefficient of the point

a_i = average distance of i to the points in its cluster

b_i=average distance of i to points in neighbouring/second best cluster



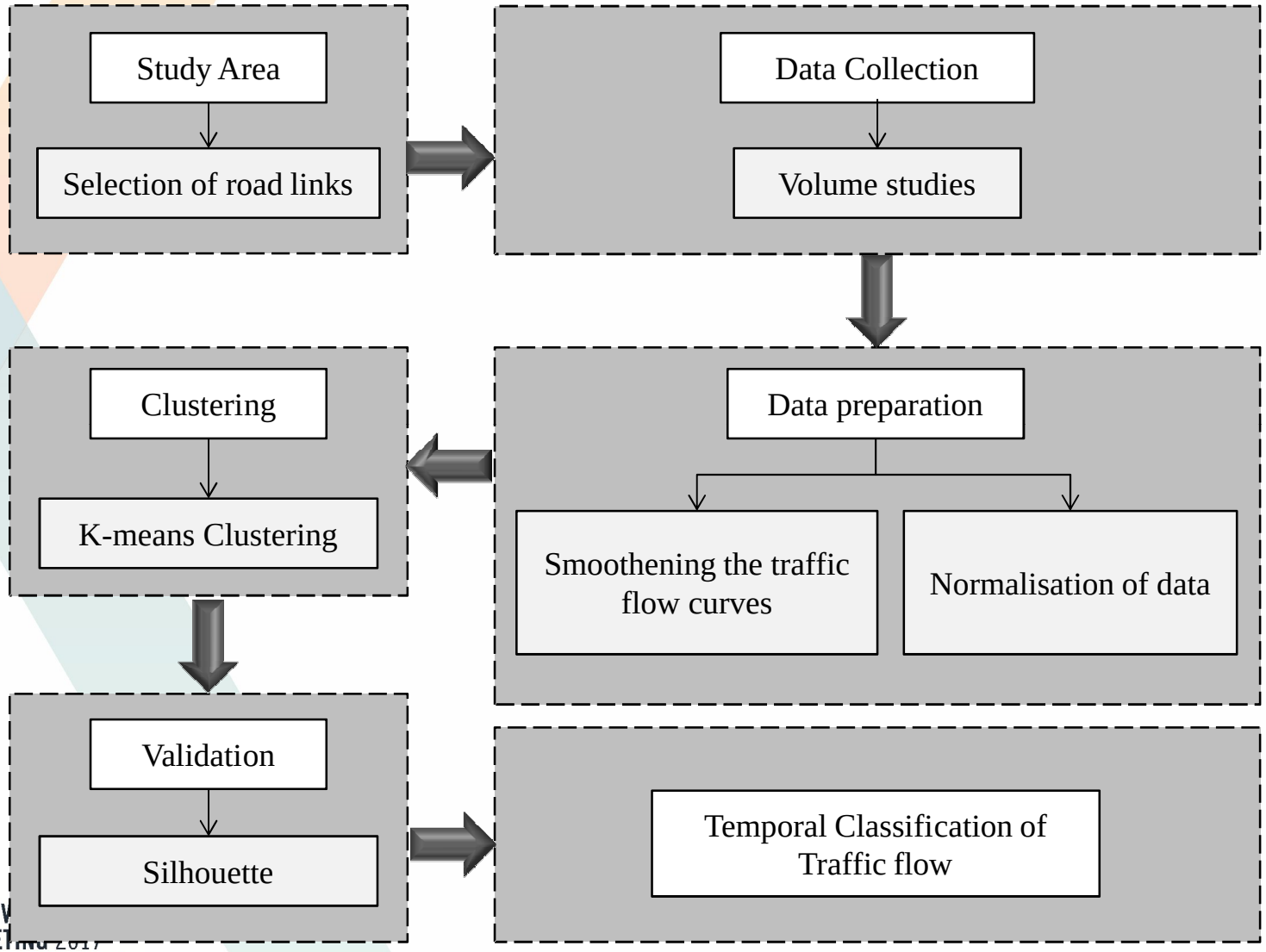
CLUSTER VALIDATION

Silhouette

- Silhouette value closer to 1 is desirable
- Negative value indicates ai > bi

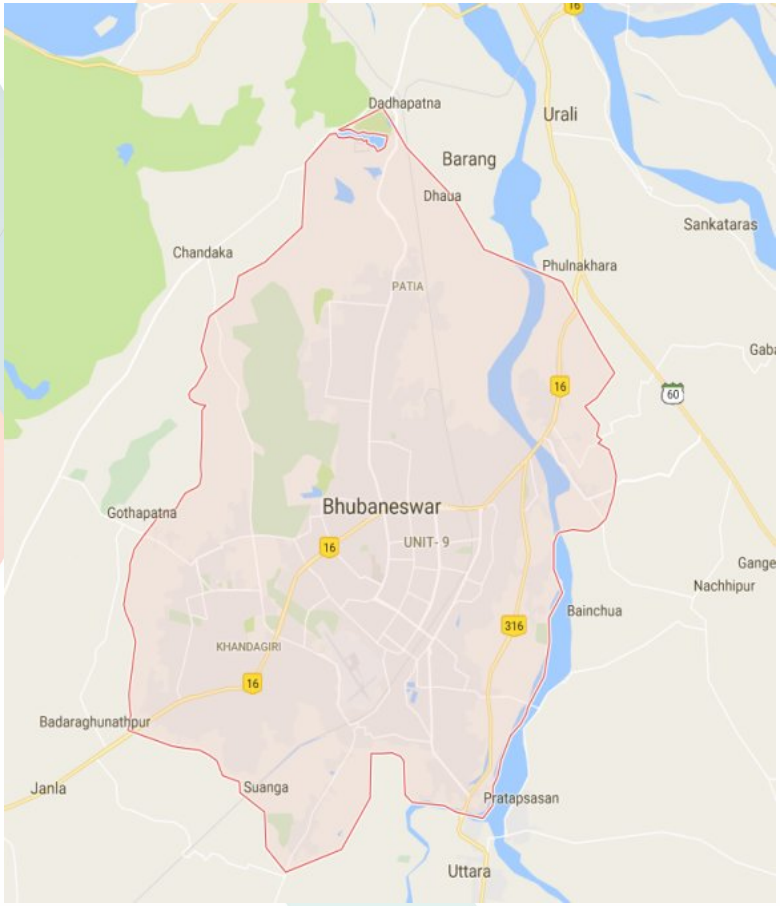
Range of Silhouette Value	Interpretation
0.71-1.0	A strong and robust cluster has been formed
0.51-0.70	A reasonable cluster has been found
0.26-0.50	The cluster is weak and could be artificial
-1.0- 0.25	No substantial clustering can be found

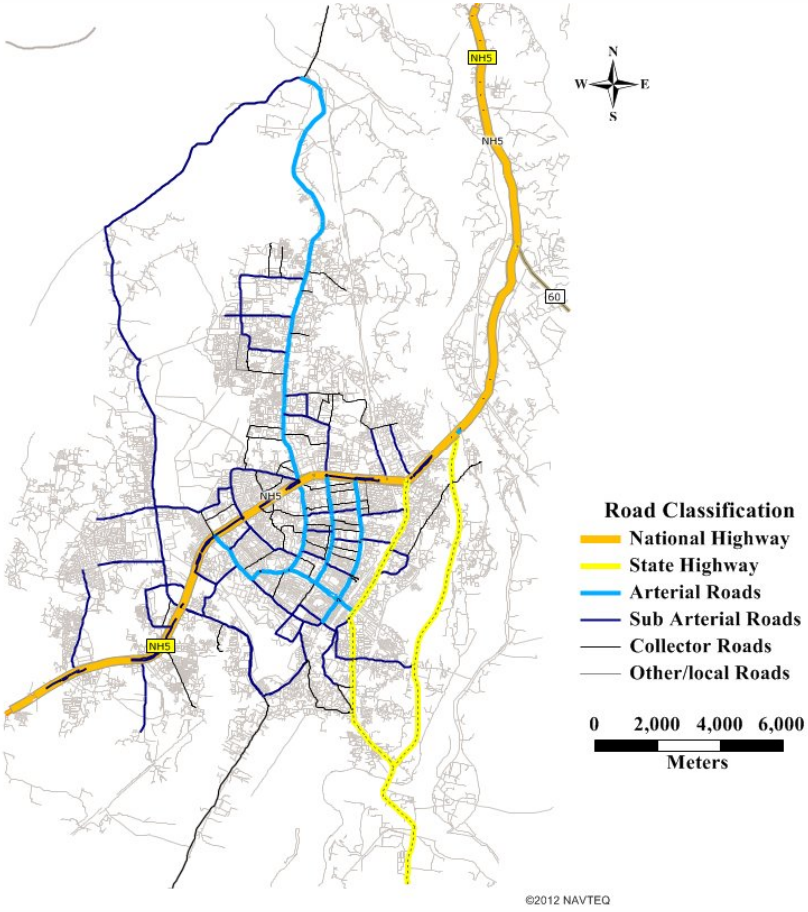
STUDY APPROACH



STUDY AREA

Bhubaneswar City

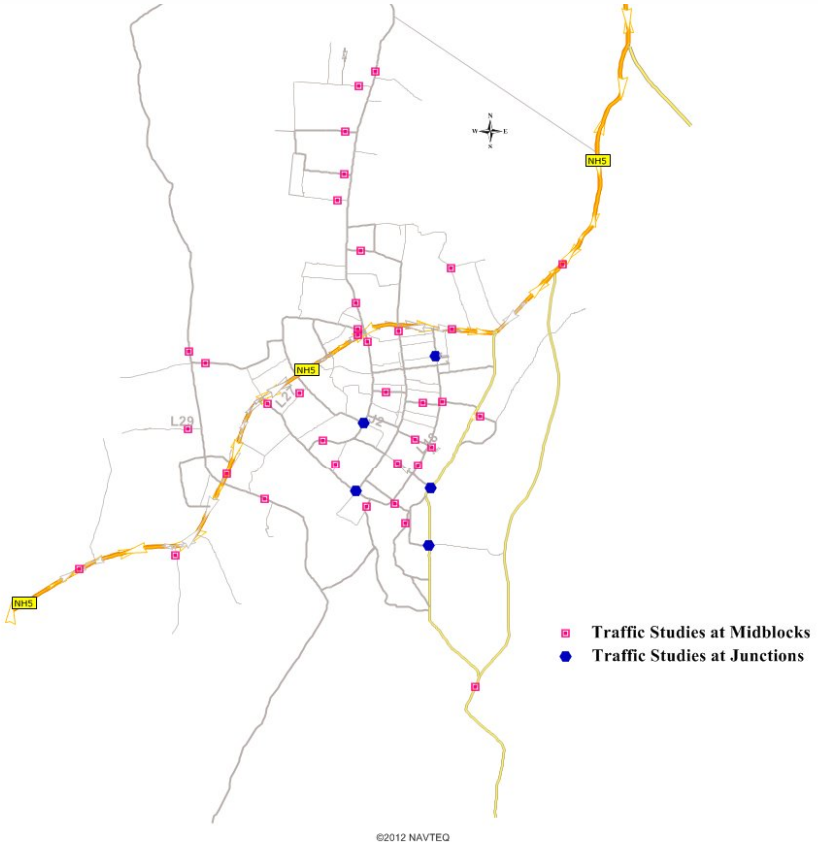




VOLUME STUDIES

Bhubaneswar City

- Conducted a city-wide detailed traffic volume survey
- Duration of Survey at a location : 16 hours (6:00 a.m. to 10:00 p.m.)



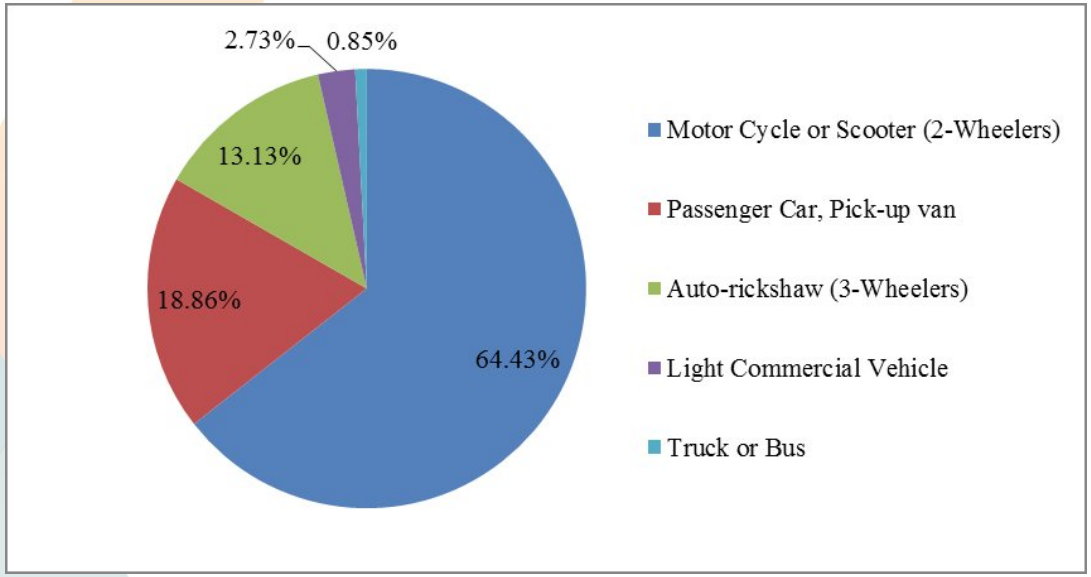
DATA COLLECTION AND DATABASE DEVELOPMENT

Traffic Volume Studies

- Video-graphic based survey was conducted
- Information are collected for every 10 minutes interval
- Number of two wheelers, three wheelers, car/jeep, multi carrier, bus, light commercial vehicle, and others are counted

Volume Studies in BBS

DATA COLLECTION AND DATABASE DEVELOPMENT

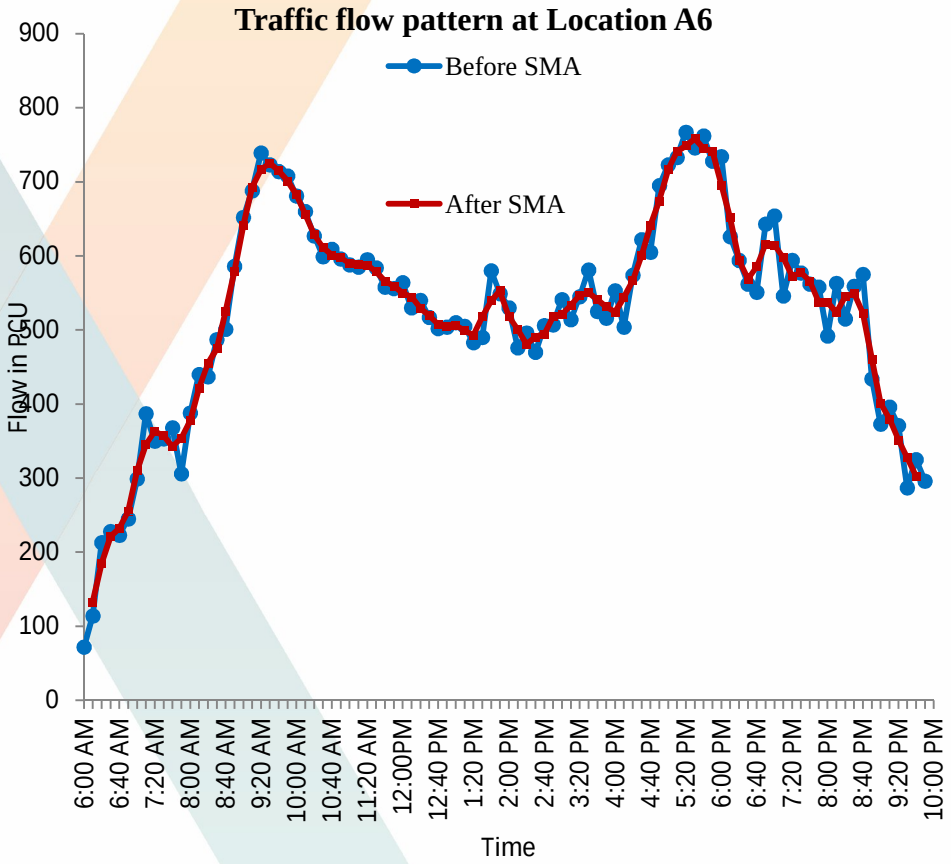


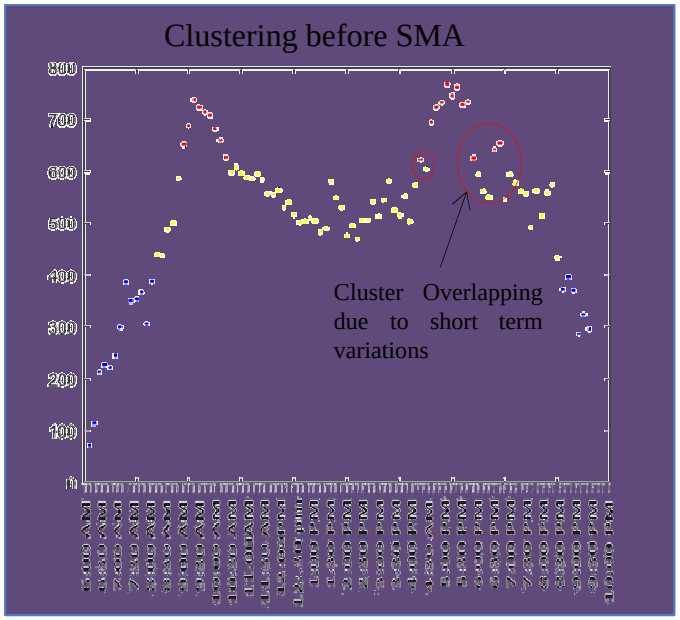
Passenger Car Units

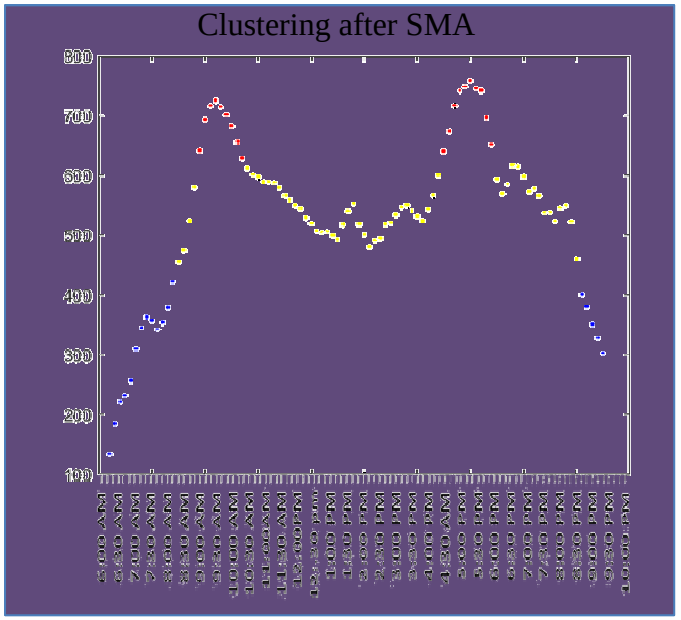
S. No.	Vehicle Type	Equivalency Factor	
		5%*	>= 10%*
1	Motor Cycle or Scooter (2-Wheeled)	0.5	0.75
2	Passenger Car, Pick-up van	1	1
3	Auto-rickshaw (3-Wheeled)	1.2	2
4	Light Commercial Vehicle	1.4	2
5	Truck or Bus	2.2	3.7

* Percentage composition of vehicle type in traffic stream

SIMPLE MOVING AVERAGE







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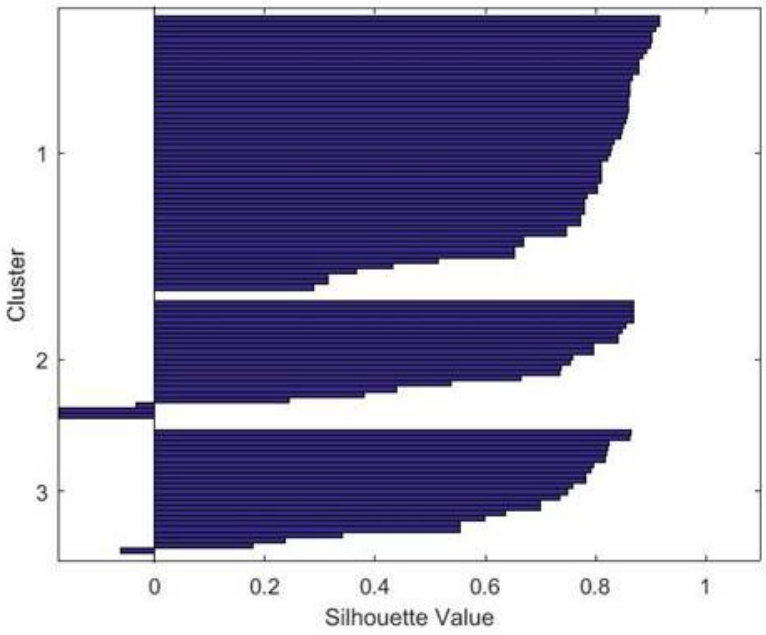
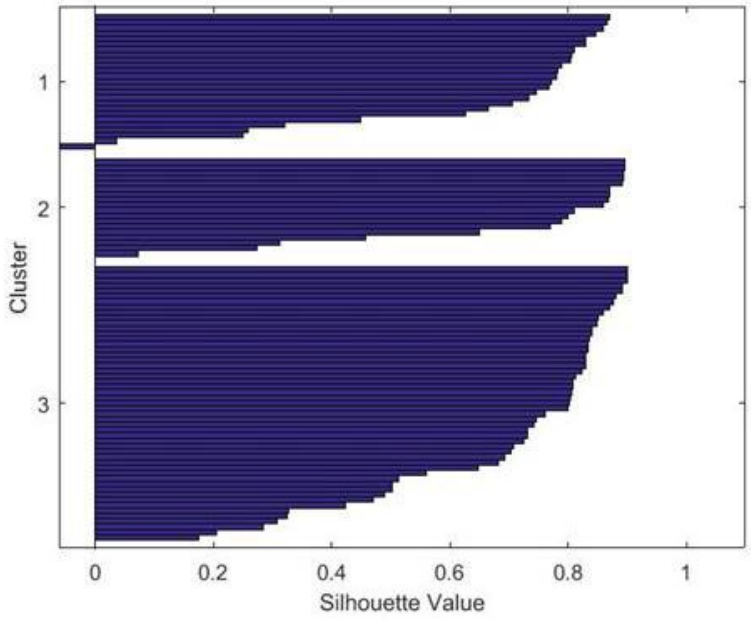
SIMPLE MOVING AVERAGE

Silhouette Plot

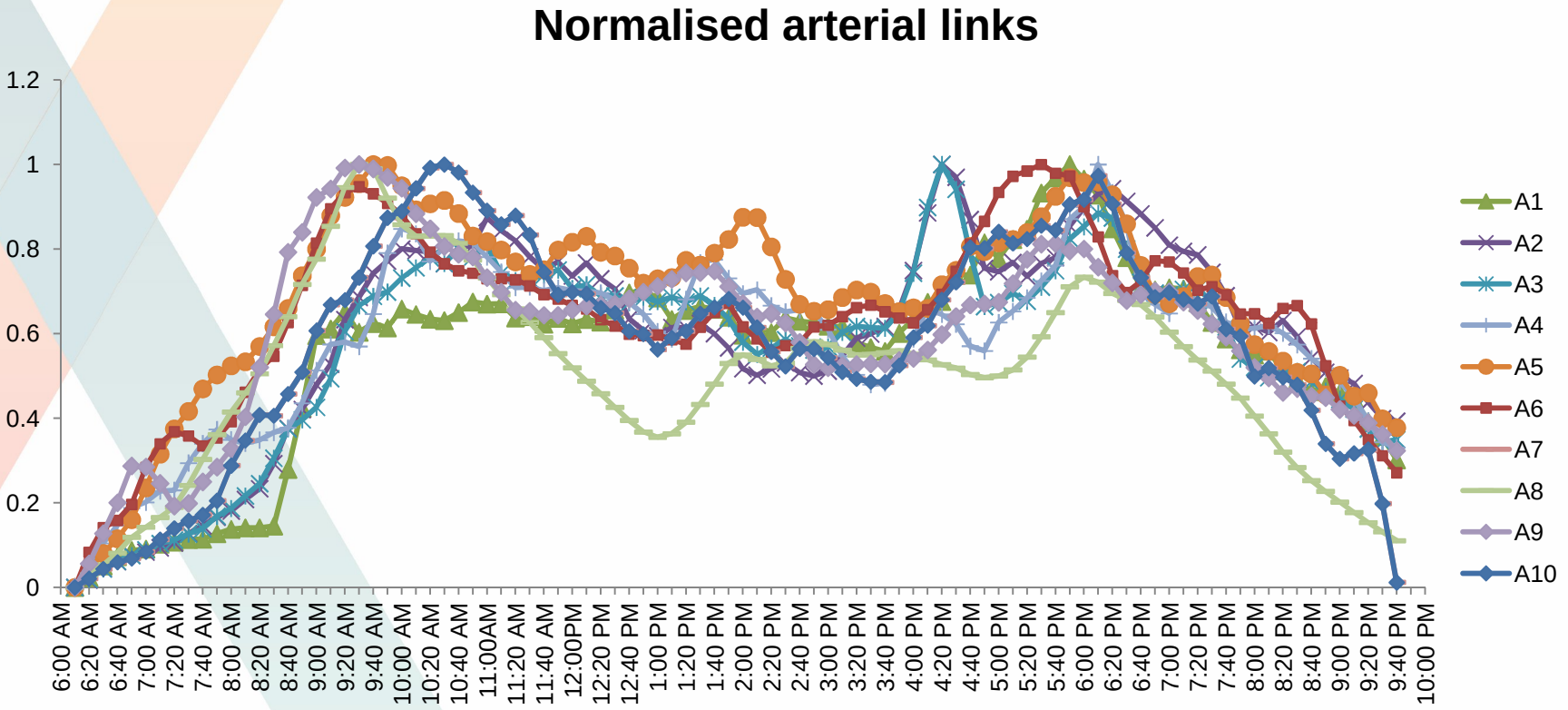


Before SMA

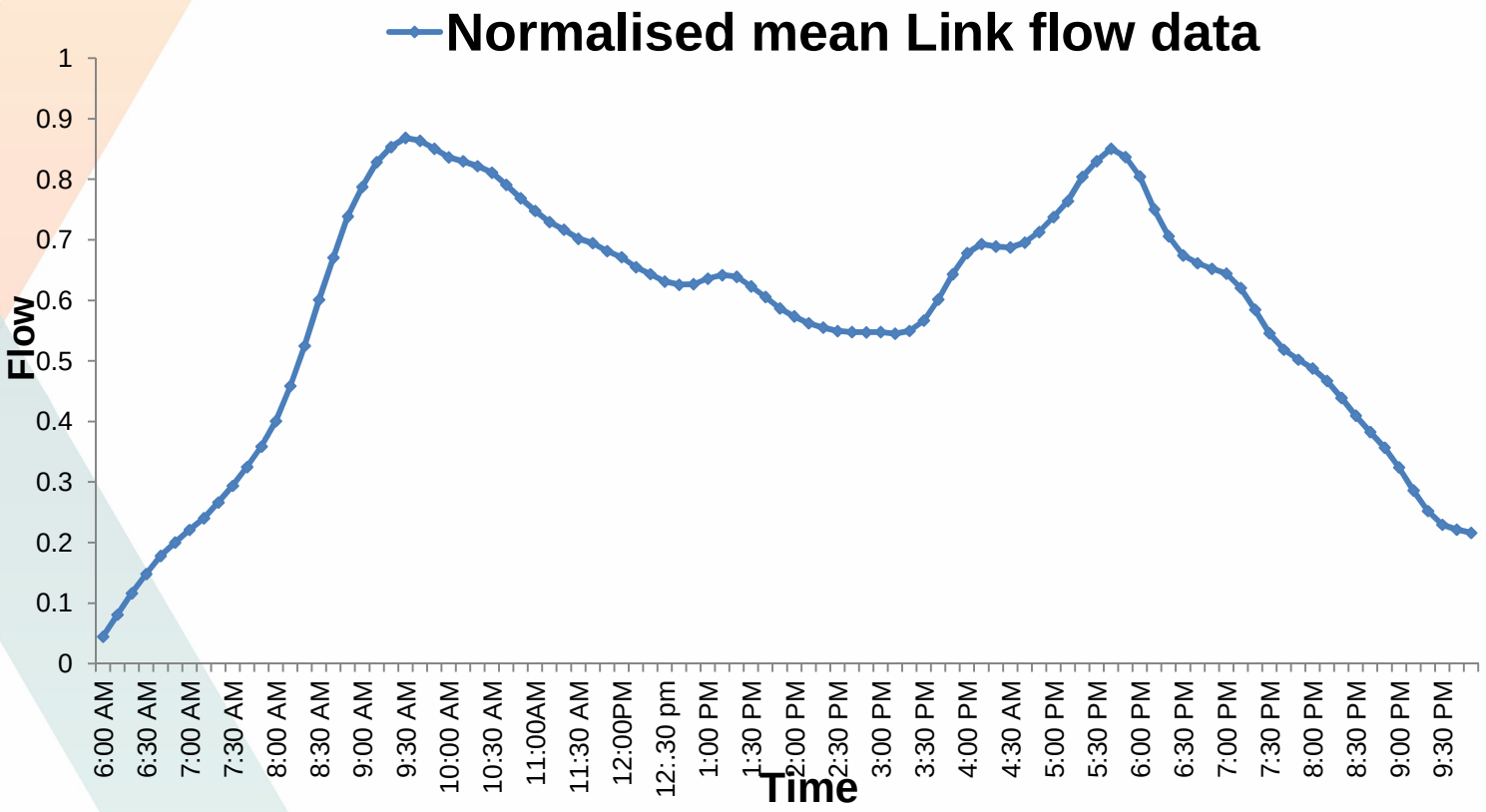


After SMA

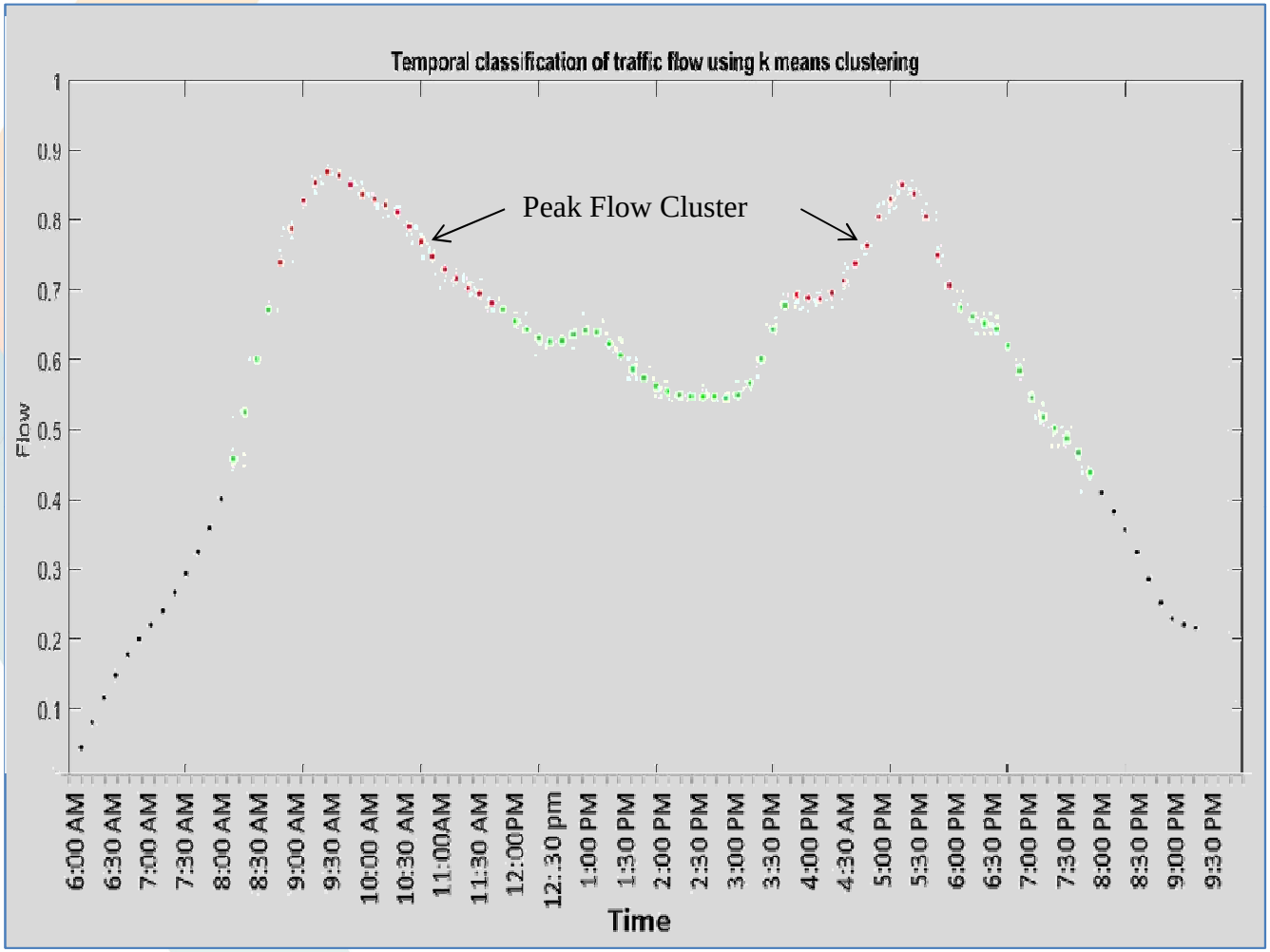
ARTERIAL ROADS



ARTERIAL ROADS



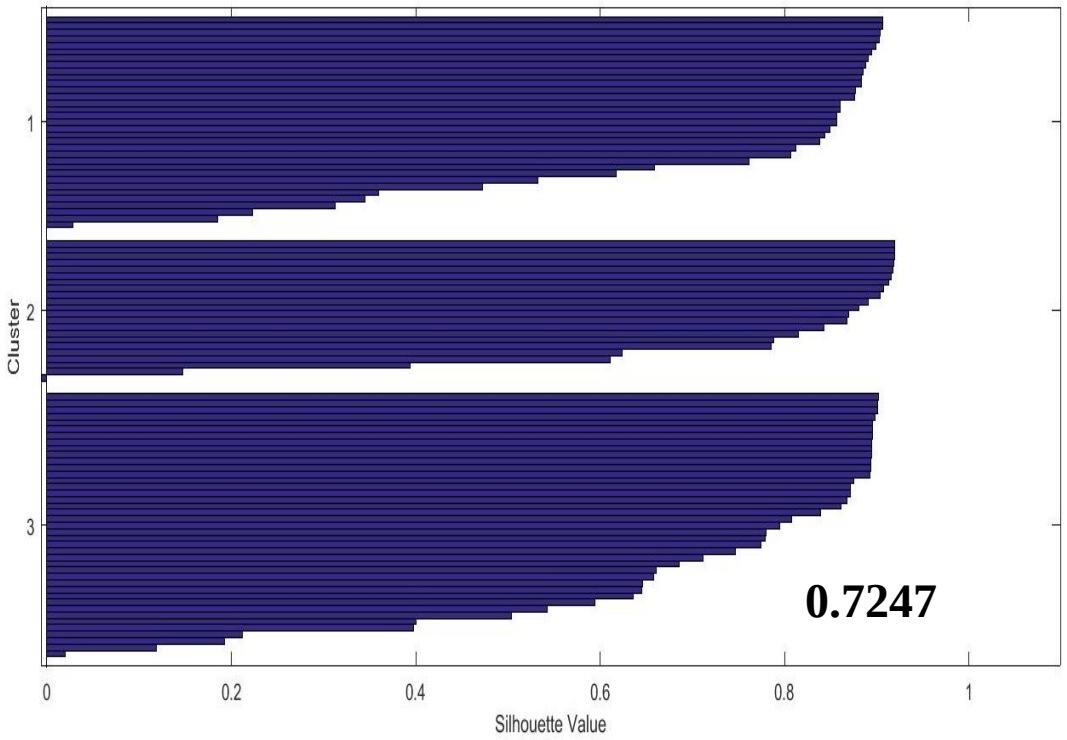
TEMPORAL CLASSIFICATION USING K MEANS



The peak durations identified for the city are 8:50 am to 12 noon (morning peak) and 4 pm to 6:20 pm (evening peak)

TEMPORAL CLASSIFICATION USING K MEANS

Silhouette Plot



CONCLUSION

- The study demonstrates a cluster based approach for temporal classification of urban traffic flow pattern in order to identify the peak and off-peak durations
- The study classifies the within-day traffic flow pattern by considering inherent temporally continuous nature of traffic flow data
- The peak durations identified for the city are 8:50 am to 12 noon (morning peak) and 4 pm to 6:20 pm (evening peak)

CONCLUSION

- Although, this result is case specific, the approach demonstrated may be used for rational identification of time periods of traffic flow in other urban areas
- This approach can be used for single links/ expressways
- This approach is more suited for mid size cities for city wide temporal classification of flow patterns
- The other clustering approaches may be explored to compare and validate the current cluster structure for identification of peak and off-peak durations

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ROAD NETWORK

Thank You

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