Traffic Prediction in Urban Road Networks
- Comparison of Regressive Approach & Pattern Approach

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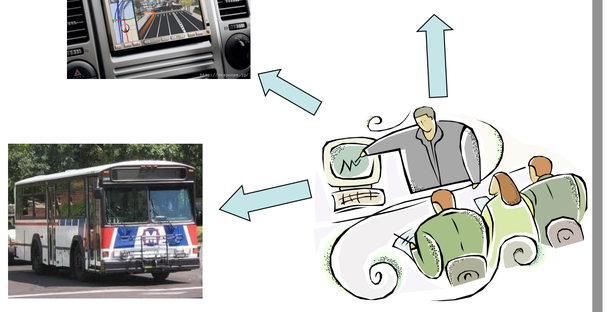
Introduction

•Intelligent Transportation System (ITS) refers to information and communication technology that improves transportation outcome.

•**However,** the benefits of ITS cannot be fully realized if traffic is not "known" in advance or forecasted.



Related Work: Previous Efforts

•Regressive / Statistical Typical Approaches

- Auto-regressive integrated moving average (ARIMA)
- Exponential Smoothing (ES)
- Neural Network Models (NNet)
- Non-parametric Regression (NPR)

Limitation: lack of domain knowledge (e.g., people travelling behavior)

•Other Approaches

- Historical Average Models

Limitation: no way to react to dynamic changes, such as events

Forecasting Problem & Approaches

•Problem Formulation

- Input: speed time series (i.e., $\{y_i\}$ 1 <= i<= N)
- Output: future speed values in M time stamps.

  i.e., $\{y_k\}$ (N+1<=k <=N+M)

•Regressive Solution

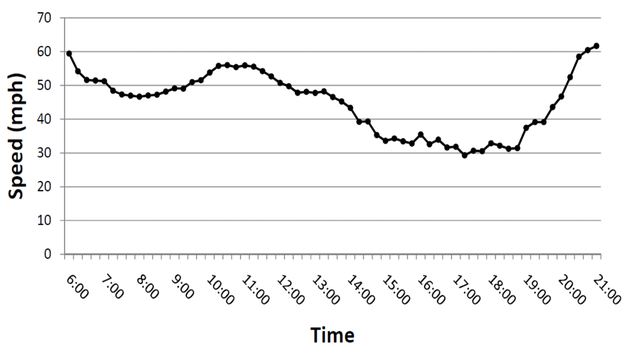
- ARIMA Model

$$y_t = \sum_{k=1}^{p} \phi_k \bullet y_{t-k} + \sum_{k=1}^{q} \theta_k \bullet \varepsilon_{t-k} + \varepsilon_t$$

- Key Features:
  - Models the relationship between current variable with previous variables & noise.
  - Only predicts 1 variable ahead, and accuracy may decrease if use predicted values as known values

•Pattern Solution

- Pattern: daily speed sequence (itself is used as predicted value).
- Key Features:
  - Patterns are integrated with people traveling behavior, e.g., people go to work Mon-Fri, do not go to work at weekends.
  - Patterns filter out all the noises, so it is incapable of predict events.



Sample Pattern Visualization

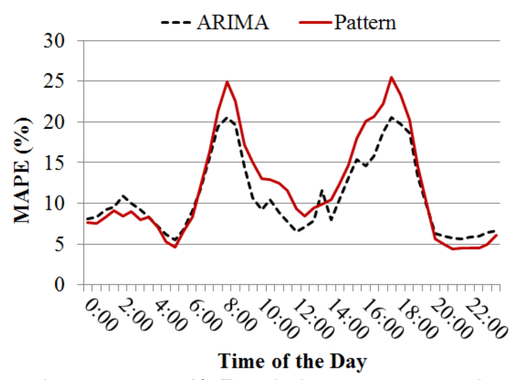
- Pattern Categories:
  - Regular: Mon~Sun
  - Long Weekend: Fri~Tue
  - Thanks Giving: Wed~Mon
  - Special Event: Sat, Sun

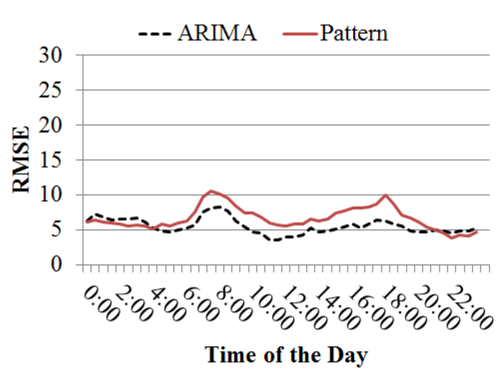
Experiments

•Experimental Setup

- Spatial Coverage: 450 sensors from Los Angeles freeway
- Training data: Nov, 2011 / Testing data: first week in Dec, 2011
- Data Resolution: 5-min
- Forecasting interval: 30 minutes (i.e. M = 30 / 5 = 6 time stamps)
- **Measures of effectiveness**
  - **MAPE (%) =** $\frac{1}{n}\sum_{i=1}^{n}\frac{|y_i - \hat{y}_i|}{y_i}\times 100$ **RMSE =** $\sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}$

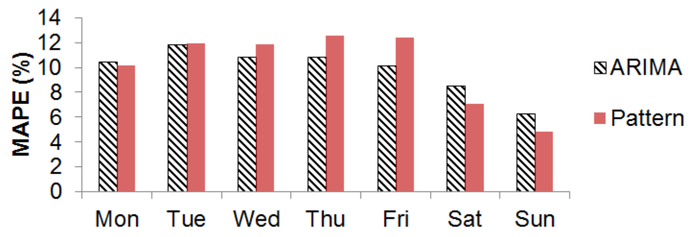
•Effects of Hours in a Day (All Sensors, Wednesday)





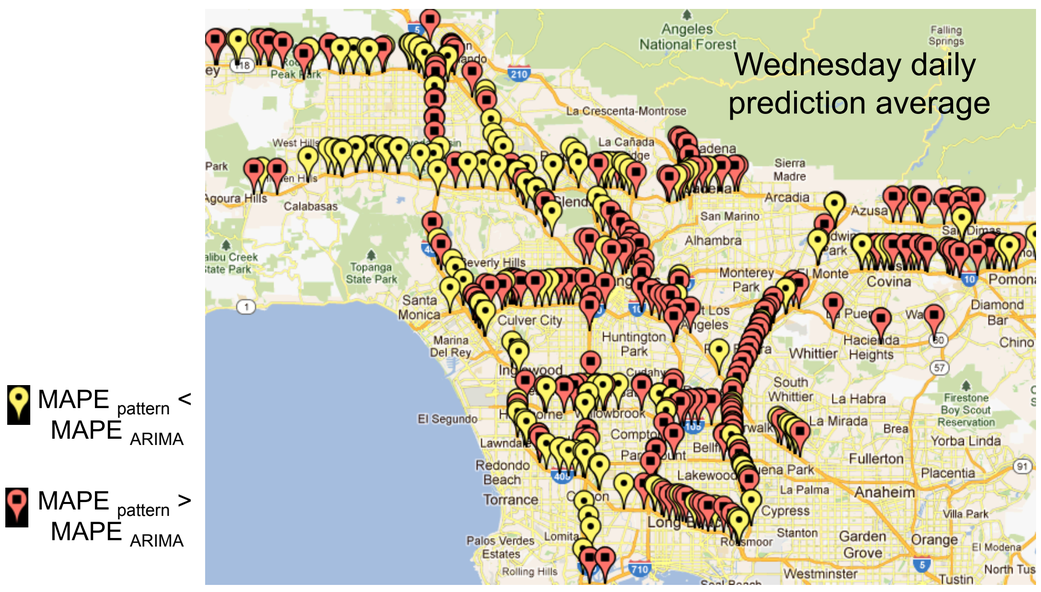
•Observations: 1) Rush hour congestion makes prediction harder
2) Pattern approach is better when there is free flow traffic

•Effects of Days in a Week (All Sensors, All hours)



•Observations: 1) ARIMA approach provides better prediction during weekdays, because weekday data takes a larger portion of the training data.
2) Pattern approach is better when it comes to weekend

•Effects of Location



MAPE $_{pattern}$ < MAPE $_{ARIMA}$

MAPE $_{pattern}$ > MAPE $_{ARIMA}$

•Observations: 1) ARIMA approach provides better prediction for specific regions or freeways, for example, downtown area, I-10, I-605.
2) Pattern approach is better when it comes to less-event area, where traffic mostly follows the cyclical nature.

Conclusion & Future Work

•Conclusion

- This study empirically compares the pros & cons of regressive approach and pattern approach on traffic prediction problem.

•Future work

- Introduce domain knowledge while training the regressive model.
- Enrich the pattern categories with event/accident pattern etc.

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