Travel Speed Forecasting using Continuous Conditional Random Fields

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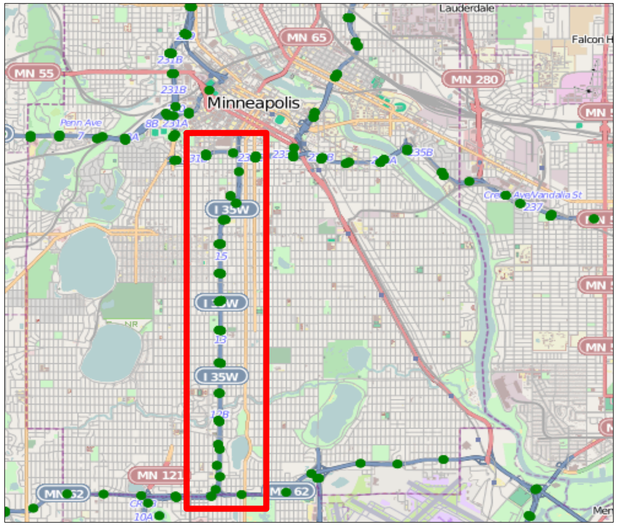
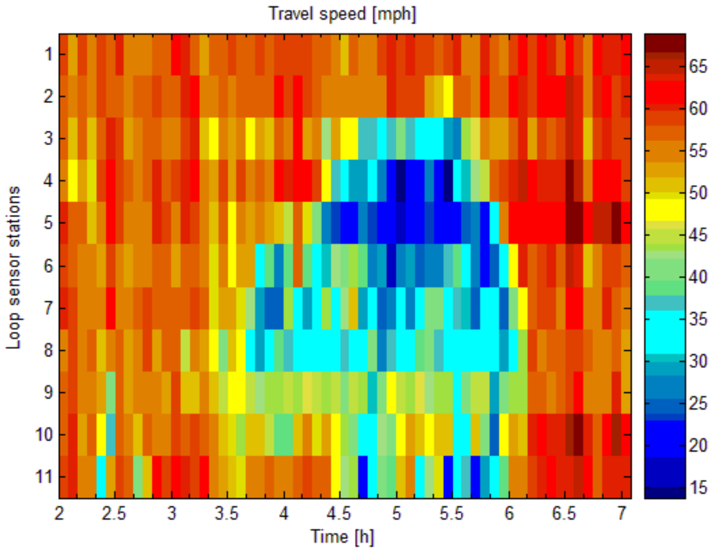
Issues in travel speed forecast

- Many proposed predictors
  - How to integrate them?
- Inherent correlations between variables
  - Speeds at neighboring road sections
  - Speeds at neighboring time intervals
- Missing data issue
  - Sensor failures
  - Might pose a serious problem

Problem setting

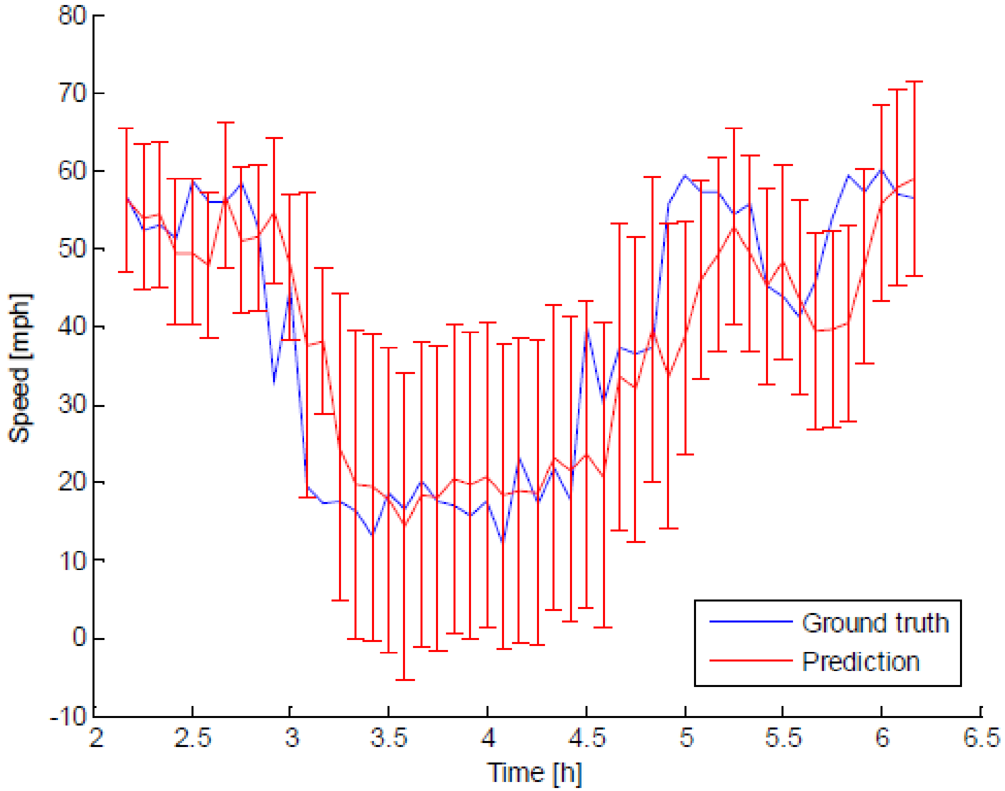
- Predict travel speeds on I-35W highway, Minneapolis, MN, from April to July, 2003
- Up to 1h ahead, in 10-min increments, across 11 consecutive sensor stations





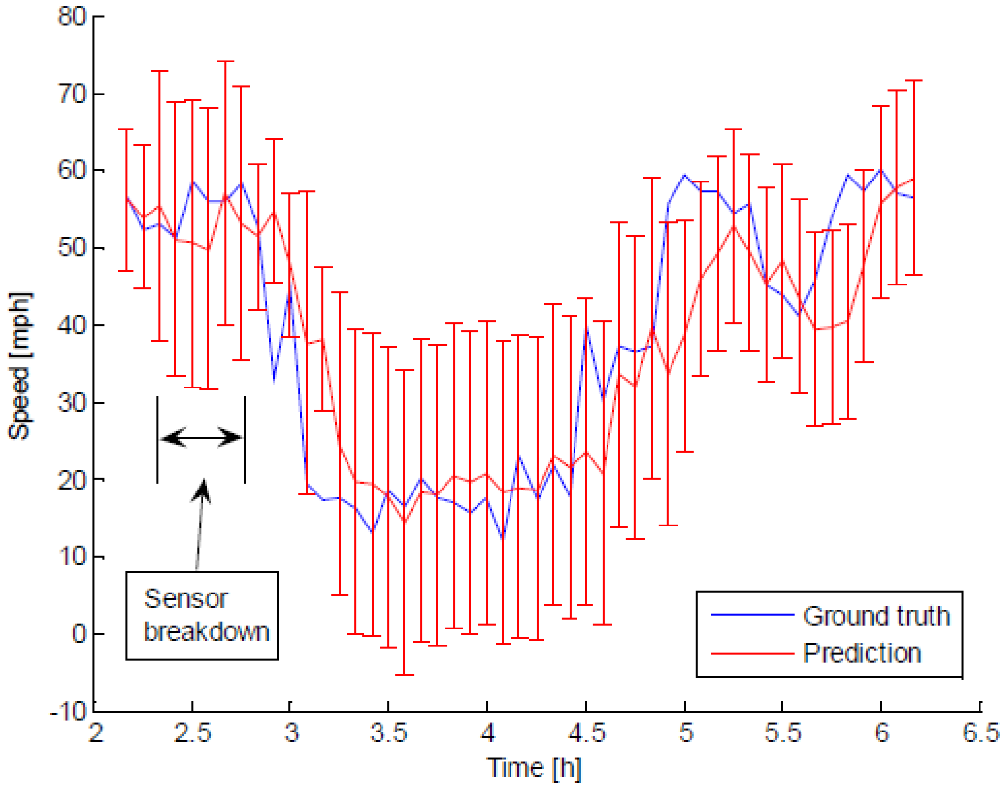
Results

- Predictions for 10-min horizon:



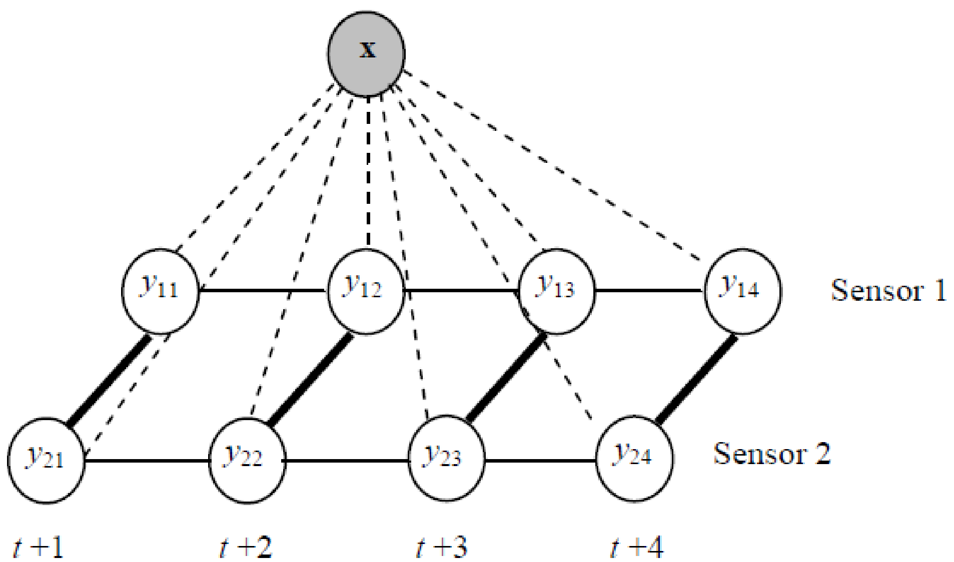
Results – Missing data

- Model still predicts, but with less confidence:



CCRF model

- Undirected graphical model
- Uses all available data **x** (sensor readings, historical data, weather forecast, …)
- Outputs predictions **y** (<u>speed</u>, volume, occupancy, …)



CCRF model – Cont'd

- Conditional distribution

$$P(\mathbf{y} \mid \mathbf{x}) = \frac{1}{Z(\mathbf{x}, \boldsymbol{\alpha}, \boldsymbol{\beta})} \exp\left(\sum_{i=1}^{N} A(\boldsymbol{\alpha}, y_i, \mathbf{x}) + \sum_{i \sim j} I(\boldsymbol{\beta}, y_i, y_j, \mathbf{x})\right)$$

- ***A***ssociation and ***I***nteraction potentials

$$A(\boldsymbol{\alpha}, y_i, \mathbf{x}) = -\sum_{m=1}^{M} \delta_{mi}(\mathbf{x}) \alpha_m (y_i - \theta_{mi}(\mathbf{x}))^2$$

$$I(\boldsymbol{\beta}, y_i, y_j) = -\sum_{k=1}^{K} w_{ij}^{k} \beta_k (y_i - y_j)^2$$

Conclusions

- CCRF suitable for traffic forecast
  - Inherent temporal and spatial correlations in data
- Flexible model
  - Data from various predictors
  - New knowledge easily incorporated
  - New neighborhood definitions
  - Regime-switching
- Robustness to sensor failures

Visit our poster at:

Innovations in Transportation Network Modeling

Time: Tomorrow, 2:30PM- 5:00PM

Location: Hilton, Washington DC