Travel and Transportation in the Age of BigData

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Outline

• ADMS - Data Collection and Integration
• TRAVICS - Predictive Transportation Analytics
• ClearPath - Route Planning
• FleetR - Route Planning for Fleets
• SBus - Public Transportation Analytics
ADMS
Data Collection and Integration

• **Research:** Collect, store and integrate real-time transportation data from 15K+ sensors and 7 Agencies
  - Efficient retrieval and storage of high-rate streaming data
  - Design and implement scalable database
  - Integration of sensor, road network, and socio-economic datasets
ADMS
Data Collection and Integration
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- **System**: ADMS to be used by LA Metro
ADMS
Data Collection and Integration

- **System:** ADMS to be used by LA Metro

- Did Expo Line increase transit patronage?
- Did Expo Line impact traffic performance?
**TRAVICS**

Predictive Transportation Analytics

- **Research:** Traffic Prediction
  - What is the traffic speed in the h-th minute? (h: prediction horizon)

- Limitation of out-of-box prediction tools
  - Traffic dynamics make it hard to use out-of-box M/L techniques for accurate prediction
  - Cannot predict sharp speed changes at the boundaries of rush hours
  - Cannot predict the traffic speed in a long term range (with large h)

- Locally Weighted ARIMA (Autoregressive integrated moving average)
**TRAVICS**

**Predictive Transportation Analytics**

- **Research:** Event Impact Prediction
  - Traffic Collision
    - I-5 S. at Colorado Blvd
    - 10/30/2012 (Tuesday) 3:00 pm
  - Impact Modeling
    - Spatial and temporal models
    - Autoregressive integrated moving average (ARIMA)
TRAVICS
Predictive Transportation Analytics

- **Research**: Context Aware Online Traffic Prediction
  - Joint work w/ Prof. Mihaela Van de Schaar (UCLA)
  - Context: time, space, event, weather
  - Use context to select the predictor
  - Online Learning: Reward the predictors
TRAVICS
Predictive Transportation Analytics

• **Research**: Origin/Destination (O/D) Matrix Estimation
  • Determine the underlying behavior of the system
  • Determine the needs of the system
  • See invisible problems
  • Plan more accurately

• O/D Matrix Estimation:
  • Surveys:
    • Costly and inaccurate
  • Vehicular sampling
TRAVICS
Predictive Transportation Analytics

- **Research**: Origin/Destination Matrix Estimation
  - Modelling problem as Linear Opt
  - Finding K-Shortest path for ODs.
  - $\min_x ||Ax - b||$.
  - $A$: Structure of road network and traffic congestion.
  - $b$: Sensed traffic counts.

![Graph showing distribution of number of OD pairs with certain size of flow](image1)
![Map showing major estimated OD flows](image2)
TRAVICS
Predictive Transportation Analytics

- **System**: TRAVICS– Traffic Event Surveillance and Analysis System

[ JSTSP15, SSTDM14,ICMD13,ICDM12,SIGSPATIAL11, SIGSPATIAL10], Underlying Technology for Many Apps
ClearPath
Route Planning

- **Research:** Time-dependent Route Planning
- “Predict-and-Avoid” instead of “Detect-and-React”
ClearPath
Route Planning

- **System**: ClearPath – a web and mobile platform that saves on average 18% travel time over Google
ClearPath
Route Planning

• **System:** ClearPath – a web and mobile platform– that saves on average 18% travel time over Google

• **Raised:** $1.2M from MM Partners, Amplify and TJS; and licensed from IMSC in December 2014
FLEETR
Route Planning-2

**Research:** Vehicle Routing in Time-dependent Road Networks

- **Input:**
  - Time-dependent network $G(V,E,T)$
  - $n$ customers with locations, $m$ vehicles located at a central depot to make deliveries.

- **Output:** A set of routes that serve all customers at minimum cost (e.g., distance, travel time).

- **NP-Hard problem**
  - For 120 stops per day, there are $120! = 6,689,502,913,449,135,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000$ alternative s for ordering.
FLEETR
Route Planning-2

- Year 1: Develop Heuristic Based Algorithms
  - Nearest Neighbor Heuristic (NNH)
  - Sweep Heuristics
  - Integrate with Oracle Spatial framework
- Year 2: Local Search Improvement
  - Extend heuristic algorithms with Local Search to improve accuracy
  - Accuracy: Improved 22% with respect to Year 1, and now within 3% of best known solution
FLEETR
Route Planning 2

• Experiments with real-world dataset from Velocity Express
  – 258 nodes, 9 cars (routes) with capacity= 30
  – Running time: 52 seconds

https://routific.com/: The smaller the orders, the quicker Routific can come up with a solution. For ~50 orders and ~15 vehicles, an API call takes about ~30s. For ~250 stops and ~15 vehicles, it takes about 2 minutes.
FLEETR

Route Planning 2

- **System**: FLEETR - Time-dependent Vehicle Routing

No. of vehicle
3

Depot
87952

Delivery points
- Browse: deliveryWithCords.json

Setting Date
Monday

Setting Time:
8:15 - 10:15

Heuristic
TD_Sweep

Submit

We think you had better schedule 52 more minute(s) and choose more vehicle(s) ~

Total Time (H:M:S)
2:52:2
SBus
Public Transportation Optimization

- **Research**: Public Transportation Analysis and Planning
  - Real-time monitoring – situational awareness
  - Bus route reliability
  - Delay prediction based on real-time traffic
  - Plan trips based on expected delays
SBus
Public Transportation Optimization

• **System**: SBus- A Real-time Transit Vehicle Analytics Framework
Questions?

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Next Speakers

10:30 - 10:50  Vehicular Sensing, Communication, and Green Transportation
   Bhaskar Krishnamachari,
   Associate Professor of Electrical Engineering, USC

10:50 - 11:10  Context-Aware Online Traffic Prediction
   Mehaela van der Schaar,
   Professor of Electrical Engineering, UCLA