Advanced and Predictive Analytics in Transportation Systems

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TransDec: Data-Driven Decision Making in Transportation Systems

- A collaborative project with LA Metro and IMSC (3 years)
- Fuses 15TB+ annual data from
  - 11K loop-detectors with update rate 30 sec,
  - Location information of 2K busses and trains,
  - Accidents (~400/day), and ramp meters in LA
- A system which enables spatiotemporal queries in transportation systems with dynamic, real-time and historical data
Summary of Activities

• Transformed Big Transportation Data into actionable knowledge for decision makers
  • Real-time Monitoring
  • Corridor Management
  • Regional Monitoring

• Developed next-generation navigation system – ClearPath (2013) that saves \%18 time for typical drivers
  • The solution not only considers what traffic is like now, but also forecasts how it will behave
  • Predict-and-Avoid instead of Detect-and-React
  • Fundraising
Summary of Activities (Cont.)

• Traffic Prediction
  – Predicted short term and long term traffic [ICDM’12]
  – Predicted incident impact (backlog and clear-time) on road networks [ICDM’13]
  – Implemented a web based accident analysis system

• Vehicle Routing for Fleets
  – Extended ClearPath’s technology
  – Joint project with Oracle to develop time-dependent routing for delivery vehicles

[ICDM’13] B. Pan, U. Demiryurek, C. Gupta, and C. Shahabi, **Forecasting Spatiotemporal Impact of Traffic Incidents on Road Networks**. IEEE International Conference on Data Mining.

Outcome

• Received 2013 Oracle Spatial And Graph Excellence Award in Education and Research

• 2 Patents issued
  – Hierarchical and exact fastest path computation in time-dependent networks US8660789 B2
  – Efficient k-nearest neighbor search in time-dependent spatial networks US8566030 B1

• Presented ClearPath at Connected Car Expo

• Extended LA Metro Project

• Pursued Fund Raising: NSF and FHWA

• Continued Research
  – Initiated a joint transportation project with Germany – Uncertainty of Routes
Incident Impact Modeling & Prediction
Incident Impact Modeling & Prediction

- Traffic Collision
  - I-5 S. at Colorado Blvd
  - 10/30/2012 (Tuesday) 3:00 pm

- Impact Modeling
  - Spatial and temporal models
Incident Analysis Demo
Time-dependent Fleet Routing
Time-Dependent Fleet Routing

- Time-Dependency:
  - Arrival-time to an edge determines the travel-time on that edge

- Calculate routes based on time-dependent traffic patterns to minimize the total delivery time?
- Find the best start-time of delivery?
- Decide the least number of vehicles for delivery?
- Finish the delivery with time-windows?
TDVR-Oracle Spatial Integration

Client Tier
- VRP Demo

Algorithm
- TD Vehicle Routing Algorithm
  - Nearest Neighbor Heuristics
  - Sweep algorithms

Application Tier
- JAVA API
  - Shortest Path Dijkstra
  - LinkCostCalculator
  - TD Graph Model

Database Back End
- Database Schema
  - Metadata Node/Link/Path/Subpath tables
  - Partition Table
  - Partition Blob Table

NDM Network Analysis: Using java API

Network Data Management

VRP Visualization

VRP Algorithms: Integrated into existing JAVA API
Time-dependent Fleet Routing Demo

USC IMSC Vehicle Routing

- Time-Dependent Vehicle Routing
  - No. of Vehicle: 3
  - Depot: 04952
  - Delivery Points: deliveryWithCords.json
  - Date: Monday
  - Time: 7:00

Output of Query

<table>
<thead>
<tr>
<th>No. of Vehicle</th>
<th>Num of Stations</th>
<th>Total Distance (mile)</th>
<th>Total Time (H:M:S)</th>
<th>Details of Routing (unit/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle 1</td>
<td>5</td>
<td>28</td>
<td>0:50:7</td>
<td></td>
</tr>
<tr>
<td>Vehicle 2</td>
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<td>63</td>
<td>2:24:4</td>
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</tr>
<tr>
<td>Vehicle 3</td>
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<td>44</td>
<td>1:39:56</td>
<td></td>
</tr>
</tbody>
</table>
Next Speakers

• Spatial and Graph Features in Oracle Database
  Jayant Sharma, Oracle

• Querying Uncertain Spatiotemporal Data
  Tobias Emrich, IMSC&LMU
Questions?

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