Responsive Traffic Management Through Short-Term Weather and Collision Prediction

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- Introduction
- Weather-Responsive Traffic Management (WRTM)
- City of Edmonton Weather and Collision Prediction
- Benefits
- Next Steps
City of Edmonton Office of Traffic Safety (OTS)

http://www.edmonton.ca/transportation/traffic-safety.aspx

- Established in 2006 as a result of Mayor Traffic Safety Task Force
- Focus on urban traffic safety through evidence-based approaches

### Shifting Rural to Urban World Population (UN Report 2009):

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban Population</th>
<th>Rural Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>3.4 billion</td>
<td>3.4 billion</td>
</tr>
<tr>
<td>2050</td>
<td>6.3 billion</td>
<td>2.9 billion</td>
</tr>
</tbody>
</table>

- The OTS will reduce the prevalence of fatal, injury, and property damage collisions through the 4 E’s of traffic safety (Engineering, Education, Enforcement, and Evaluation) by improving
  - urban traffic safety engineering
  - road user behaviour
  - speed management and
  - data, business intelligence and analytics
Weather Impacts on Safety and Mobility

- **US DOT Road Weather Management Program:**
  - In US, over 5,870,000 vehicle collisions each year - 23% (nearly 1,312,000) are weather-related.
  - On average, 6,250 fatalities and over 480,000 injuries in weather-related collisions each year.
  - 23 percent of the non-recurrent delay on highways across the US is due to snow, ice, and fog ≈ 544 million vehicle-hours of delay per year.

- Weather-related collision costs in Canada are estimated to be approximately $1 billion per year. 

- Survey indicated the importance of information on weather conditions for travelers.

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1. [http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm](http://www.ops.fhwa.dot.gov/weather/q1_roadimpact.htm); accessed on May 15, 2014.
Throughout the year, temperatures can range from below -40°C during the winter, to above 30°C in the summer.

In the City of Edmonton, around 57% of collisions occurred in the fall and winter months (January - March and October - December).

\[\text{Average 1981 - 2010}^{1}\]

\[\text{Average # days with snow depth of at least 1, 5, 10 or 20 cm on the ground (1981-2010)}^{1}\]

1981-2010 Climate Normals & Averages
http://climate.weather.gc.ca/climateNormals/index_e.html

Weather Impacts on Traffic Safety: Trends and Patterns
Weather Impacts on Traffic Safety

Weekly Count of High-Risk Violators, 2013-2014

Weather impact on collision\(^1\):
- Min Temp\(<-10\), Total Snow\(>0\) and Speed of Max Gust \(>20\) increased FTC (Followed Too Closely) collisions between 17.9% and 33.0%.

Weather-Responsive Traffic Management (WRTM)

- **Goal**: to minimize the delay and risk experienced by motorists while driving in bad weather.
- **Strategies**:
  - Advisory strategies provide warning and other information to travelers;
  - Control strategies to regulate or optimize traffic flow; and
  - Treatment strategies to ensure the roads are clear of obstructions
- **Implementation**: Integrated Transportation Management Centre

- WRTM
- Congestion management
- Advanced Traveler Information System (ATIS)
- Situational awareness and planning functionality
- Emergency operations centre capability

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WRTM - City of Edmonton’s Initiative

- Building 6 new weather stations collecting/calculating:
  - Wind speed and direction
  - Barometer pressure
  - Snow and rain fall
  - Air temperature and humidity
  - Dew point

- Weather, collision and traffic flow (volume & speed) prediction:
  - Current state: 7 days ahead prediction of citywide daily weather and collision
  - Collision prediction: public roadway collisions and police-call (CAD) collisions
  - Collaborators:
    - Weather prediction: Department of Earth and Atmospheric Sciences, University of Alberta
    - Collision and traffic flow prediction: City of Edmonton Office of Traffic Safety
    - Web-base application: Department of Civil and Environmental Engineering, University of Alberta

- Current users: the Edmonton Police Service and City of Edmonton Office of Traffic Safety
City of Edmonton Weather, Collision and Traffic Flow Prediction

- **Weather Data**: Set-up for Edmonton
- **Calendar Data**: Month, Day of Week, Holiday
- **Traffic Flow Data**: VDS Sites: Speed, Volume
- **Volume & Speed Prediction**
- **Collision Prediction**
- **Future Work**
Weather Prediction

- Predicted variables by four quadrants (NE, SE, NW, SW):
  - Wind speed and direction
  - Barometer pressure
  - Snow and rain fall
  - Air temperature (low, high, mean) and humidity
  - Visibility

- Weather data source: National Oceanic and Atmospheric Administration (NOAA)

- Use Weather Research and Forecasting model (WRF) for prediction

- Prediction accuracy:

  - RSME: Root Mean Squared Error

<table>
<thead>
<tr>
<th>Day in Prediction</th>
<th>Weather Prediction Error</th>
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<tbody>
<tr>
<td>1st Day</td>
<td>0.00</td>
</tr>
<tr>
<td>2nd Day</td>
<td>0.05</td>
</tr>
<tr>
<td>3rd Day</td>
<td>0.10</td>
</tr>
<tr>
<td>4th Day</td>
<td>0.15</td>
</tr>
<tr>
<td>5th Day</td>
<td>0.20</td>
</tr>
<tr>
<td>6th Day</td>
<td>0.25</td>
</tr>
<tr>
<td>7th Day</td>
<td>0.30</td>
</tr>
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  - Equitable Threat (skill)

<table>
<thead>
<tr>
<th>Day in Prediction</th>
<th>Weather Prediction Error: Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Day</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>2nd Day</td>
<td>1.0 mm</td>
</tr>
<tr>
<td>3rd Day</td>
<td>5.0 mm</td>
</tr>
</tbody>
</table>

ITs Canada Annual Conference and General Meeting
June 1-4, 2014 | Victoria, British Columbia, Canada
Public Roadway Collision Prediction

<table>
<thead>
<tr>
<th>Model</th>
<th>MAE</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLM</td>
<td>14.21</td>
<td>22%</td>
</tr>
<tr>
<td>GLM + ARIMA</td>
<td>12.51</td>
<td>18%</td>
</tr>
<tr>
<td>GLM</td>
<td>24.53</td>
<td>45%</td>
</tr>
</tbody>
</table>

MAE: Mean Absolute Error  
MAPE: Mean Absolute Percent Error
Police call (CAD)-Collision Prediction

MAPE 13%

ITS Canada Annual Conference and General Meeting
June 1-4, 2014 | Victoria, British Columbia, Canada
Weather and Collision Prediction: Web-Base Application

http://www.its.ualberta.ca/Default
Benefits

### Icy Curves Ahead

**Icy Curve Warning System (ICWS)**

- Deployment of the ICWS reduced the number of annual collisions by 18% (CMF = 0.82),
- PDO collision rate was reduced from 5.51 to 4.00 collisions per winter season
- Fatal and Injury collision rate decreased from 2.86 to 2.67 collisions per season
- ICWS has potentially provided safety benefits of $1.7 million dollars per winter season

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Next Steps

- Hourly predictions for the next 7 days; models updated every 6 hours
- Alarm threshold development
- Collision prediction by specific area and corridors
- Traffic volume and speed prediction
- CMF and C/B-ratio estimation
- Integration with the Traffic Management Centre
- Utilize media (radio, TV) and social media (Twitter, Facebook) to increase driver awareness
Thank You

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