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Use of Contextual Accident Prediction Methods for Road Traffic Regime Adaptation.

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Introduction

- AV and CV deployment will allow the collection of large amounts of data useful for transportation network monitoring.
  - Having large amount of data will enable optimal transportation network with respect to safety, mobility and environment
  - Large amount of data can be a source of highly relevant questions
  - Optimizing transport networks in terms of road safety requires robust prediction mechanisms

Problematic

- Prediction mechanisms issues
  - Parameters increasing the accuracy of prediction methods remain an outstanding issue
- AI techniques are increasingly used to make predictions on accidents. Related issues:
  - Diversity of AI methods for accidents predictions,
  - Impact of AI methods used on the measures to be taken against the detected road safety risks.

Main objectives

- Definition of network monitoring approach to :
- - 1) Optimize the accuracy of risk assessments in a transport network
- - 2) Increase the transport network green mobility.

Transport network monitoring process

- **Measure of various indices for risk areas identification**.
  - Main required parameters for network assessment
    - F-a :number of fatal accidents,
    - SI-a: number of serious injury accidents,
    - MI-a: number of accidents with minor injuries,
    - MDO-a: number of accidents with material damage only,
    - T-a: total number of accidents,
    - AADT: Annual average daily traffic of the considered areas.

Transport network monitoring process

- Measure of various indices of risk areas identification
    - Frequency of accidents,
    - Severity index,
    - Accident rate,
    - Critical accident rate.

Transport network monitoring process

- Measure of various indices of identification of risk areas.
  - Main relationships detecting problematic areas
    - Accident rate above the critical rate,
    - Severity index greater than the severity index calculated for the category of the area in question,
    - Accident frequency greater than or equal to four accidents per intersection over five years.

Case Study: Accident Data Processing for the City of Gatineau

- Identification of risk zones for the City of Gatineau
  - Characteristics of the City’s data accidents
    - No high accidents frequencies in the same intersections correlated with indices relations
    - Available data for prediction processing: A period of three years
  - An adaptation process is considered for risk zones identification
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Case Study: Accident Data Processing for the City of Gatineau

- Characteristics of the City of Gatineau accident data

Number of variables	Meteo	Pavement	Speed limit
1	Other	Accumulation of water	0
2	Heavy rain	Dried	10
3	Fog / Mist	Muddy	20
4	Clear	Snow	30
5	Cloudy/Dark	Melting snow	40
6	Snow/Heavy	Iced	50
7	Rain/Drizzle	Wet	60
8	Blowing snow / Snowstorm	Hard snow	70
9	Strong wind	Sand Gravel	80
10	Ice	Other	90
11			100
12			

Table 1: Set of data variables of accident registration

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- **Experimental tools**
  - – Geolocation
    - Open source software: Quantum GIS (QGIS) Version 2.14.
      - – It supports raster and vector image formats,
      - – it is compatible with Arcmap.
  - – Database used: postgresql
    - Management between geographic data and attribute data
  - – Matlab environment for data processing:
    - Prediction algorithms : Levenberg-Marquardt and Bayesian

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- **Mains cases for accident prediction variable experiments**

# Case	Combination of variables
Case #1	% 10 Meteos variables surface % 10 variables pavement surface
Case # 2	% 10 Meteos variables surface % 02 Traffic density variables % 10 variables pavement condition
Case # 3	% 10 Meteos variables % 02 Traffic density variables % 12 Speed limit variables
Case # 4	% 02 Variables - density %12 Variables - the speed limit % 10 Variables – pavement condition

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- **Mains results for accident prediction variables experiments**

# Case	Experiment results on prediction accuracy
Case #1	81 % for Levenberg-Marquardt algorithm and 92 % for Bayesian algorithm
Case # 2	54 % for Levenberg-Marquardt algorithm and 69 % for Bayesian algorithm,
Case # 3	Bayesian algorithm 90 %, Inconclusive results for Levenberg-Marquardt algorithm
Case # 4	Results with both algorithms are inconclusive

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- Experiment results conclusion:
  - Generally speaking, the Bayesian algorithm performs better than the Levenberg-Marquardt one.
  - The correlation with some parameters such as pavement condition and traffic density does not make it possible to make good predictions with the two considered algorithms.
  - More tests are required for specific parameters experiments.

Case Study: Accident Data Processing for the City of Gatineau

- **Phase 2:** Identification of areas with risk for collisions
  - Visualization of accidents throughout the City of Gatineau: 2015-2017: West of the City

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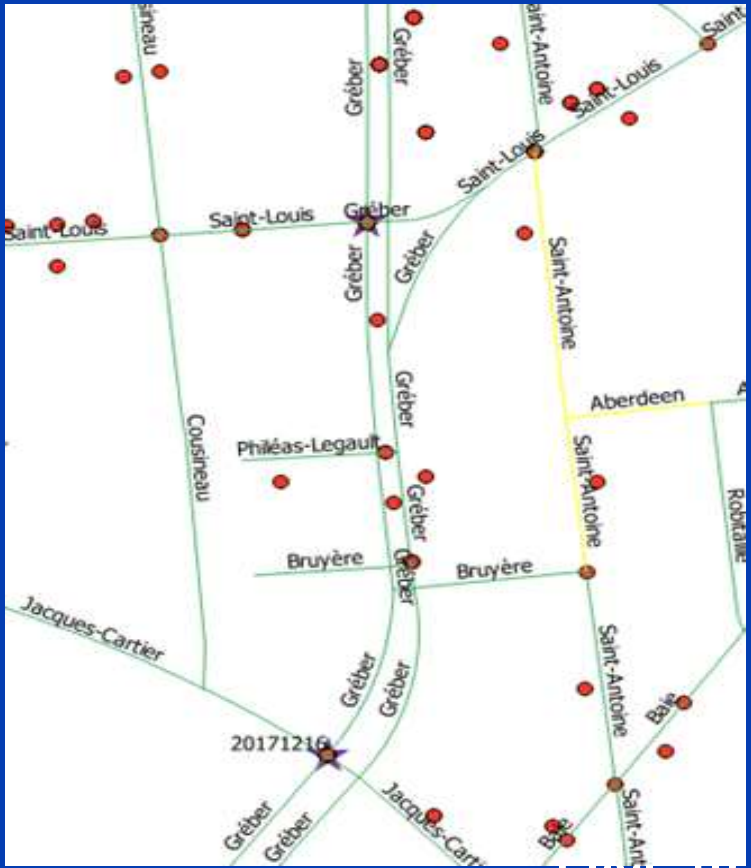
- **Identification of risk areas based on data adaptation**
  - Using the Qgis tool to filter accident data according to the parameters representing a suitable risk index.
  - Example of parameters to correlate:
    - number of injuries, number of deaths, speed limit, accidents with material damage.

Case Study: Accident Data Processing for the City of Gatineau

- **Identified Zone 1**:
  - Total of 116 Accidents over the three years
  - 02 fatal accidents
  - 9 accidents with more than two injuries.
- - 68% of accident occurred in streets at 50 km /h.



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- **Identified Zone 2**
  - Total of 18 Accidents over the three years

    01 fatal accident

    3 accidents with more than two injuries.

    100% of accidents involving more than two injuries are on dry roads.

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Identified Zone 3:

Total of 18 Accidents over the three years

01 fatal accident

4 accidents with more than two injuries.

100% of accidents occurred on streets at 50 km / h

Case Study: Accident Data Processing for the City of Gatineau

- Towards safe and green road areas
  – Methodology for risk areas processing
    - An empirical approach based on simulation
    - Using the SUMO (Simulation of Urban Mobility)
    - Integration of the risky areas of the City of Gatineau into SUMO

Case Study: Accident Data Processing for the City of Gatineau

- Towards safe and green road areas
  - Methodology for risk areas processing
    - Integration of the risky areas of the City of Gatineau into the SUMO environment via the openStreetMap.

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Case Study: Accident Data Processing for the City of Gatineau

- Towards safe and green road areas
  - **Methodology for risk areas processing**
    - Simulation and processing mechanisms
    - Traffic configuration in SUMO considering a lower speed limit than the risk zone one
    - Configuring SUMO to generate trips with the ability to evaluate travel time to deduce the level of congestion

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- Towards safe and green road area: Use of Congestion identification

Case Study: Accident Data Processing for the City of Gatineau

Search for safe and ecological conditions for Area Z1

1. Test with the current speed limit: Case 1
1.1 Identify the cruising speed of the area (special periods)
1.2 Evaluate the travel time of specific vehicles with specific departure and arrival points with cruising speed
1.3 Generate different levels of congestion based on segment capacity and vehicle speed parameters during a time period T
1.4 Assess travel time delays for each level of Traffic
1.5 Associate congestion levels with observed delays

2. Analysis of new speed limits in area Z1

For each acceptable speed limit for area Z1
a. Repeat steps 1.1 to 1.5
b. Calculate the AADT of Z1 area with the new speed limit
c. Calculate a risk index for Z1 area based on the new AADT

3.**Choosing the best speed limit to maintain**
1. Compare the levels of congestion between Case 1 and each case based on a new speed limit that becomes safe by its new AADT
2. Choose the new speed limit that provides the lowest level of congestion among the speed limits tested.

Case Study: Accident Data Processing for the City of Gatineau

- **Phase 1: Empirical study for finding the best speed limit for Case 1: Use of simulator SUMO**
  - **Existing configurations with SUMO**
    - Table : Output files of SUMO for traffic and congestion measurements

Output of SUMO	Category of information
Summary-output	Provides overall data on vehicle speed and waiting time
Tripinfo-output	Basically gives information on the duration of vehicle trips
Vehroute-output	Provides detailed information on each vehicle

Conclusion

- There is an important diversity of accident prediction methods and their input parameters
  - An empirical approach is defined in order to establish associations between data correlations and prediction algorithms derived from artificial intelligence.
  - From some experiments on a case study on the City of Gatineau, Baysian algorithm seems to be effective for most variables related to accidents

Conclusion

- With limited data on accidents:
  - Severity indices can be adapted to identify risk areas of a given City
  - Possibility to initiate processes for actions to predict and minimize risks
- **Contributions related to ecological mobility:** A new process is defined for
    - The identification of the best speed limit according to safety and the traffic densities minimisation.
  - City under study will benefit from both safe areas and ecological mobility based on coming real life experiments

Thank you !
Questions ?