Risk Analysis Tool for Safety Management of Railway Grade Crossings in Canada

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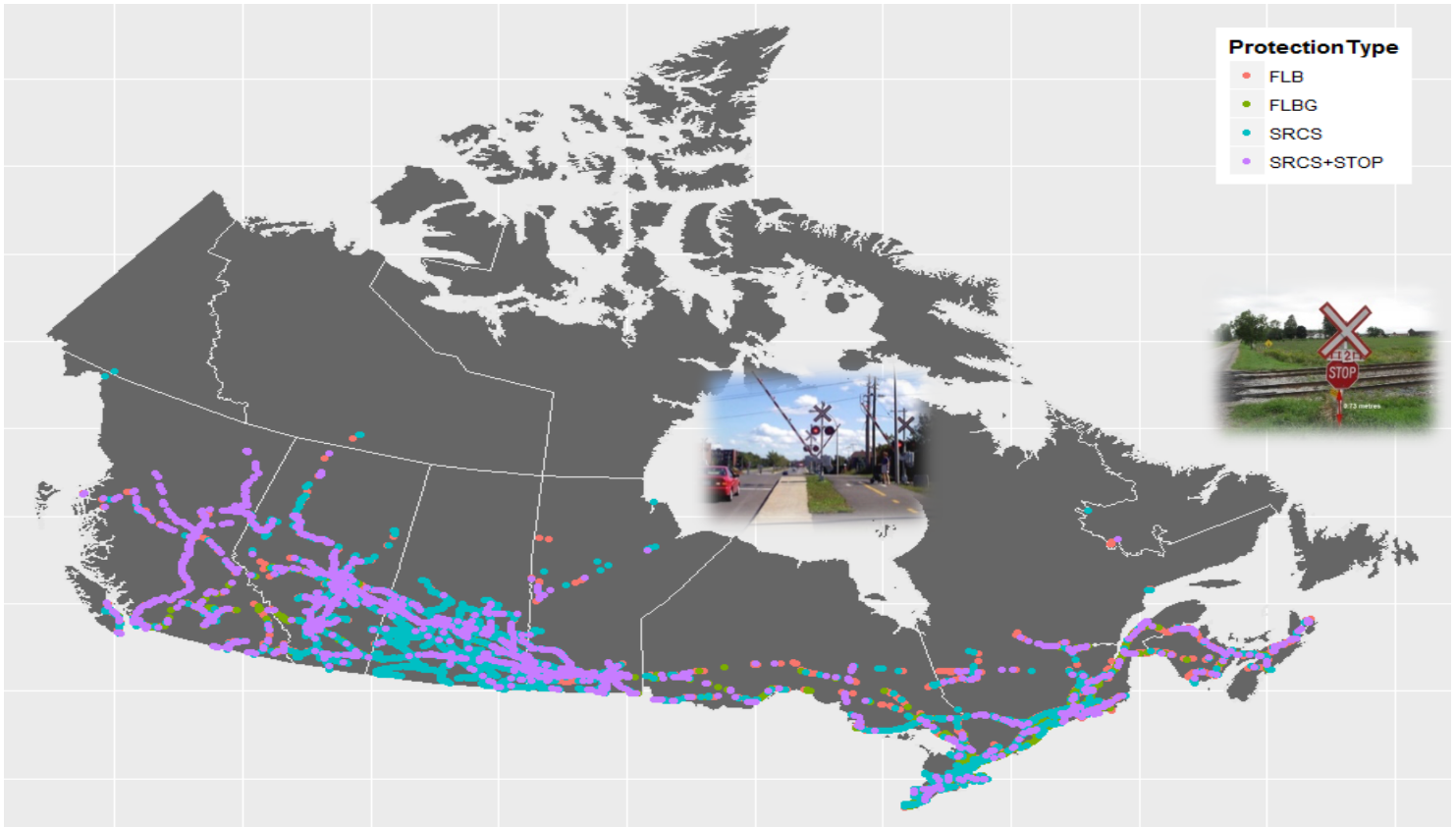
Overview

- Background
- About GradeX tool
  - Crash Frequency Model
  - Crash Severity Model
- Future research plan

Background

- Canada has over 22640 highway railway crossings across Canada.
- ~ 90% are at-grade crossings.
- Transport Canada invests in safety research for safety improvement of railway network.



Safety Research Projects funded by Transport Canada

- **Collaborative research** involving four Canadian universities
  - University of Waterloo
  - University of Alberta
  - York University
  - McGill University

- **Total five subprojects** (2018-19)
  1. **Update a risk assessment tool i.e., GradeX**
  2. Develop crossings inspection app
  3. Conduct train derailment analysis
  4. Perform safety analysis using video data
  5. Explore connected vehicle technology for safety warning at grade crossings

University of Waterloo plays the lead role for overall management of the projects

What is GradeX tool

- GradeX is a tool used for risk assessment of grade crossings
- It has a bunch of frequency and severity models for risk assessment
- Transport Canada use GradeX for:
  - Data visualization
  - Identify high-risk crossings
  - Inspection program
  - Countermeasure analysis
  - Resource allocation
- Previous GradeX models were calibrated using data from 2011 to 2013.

One of the **Objectives** of current project is to **update collision frequency and severity models** used in **GradeX**

Data Sources

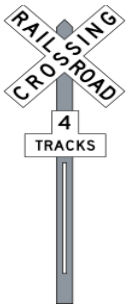
- Data obtained from Transport Canada
- Two databases utilized:
  - Crossing Inventory Database
  - Crossing Collision Database
- Databases merged using unique crossing ID

Frequency Models

- Dependent variable is total frequency of crashes occurring at each crossing over the 6 year study period.

- Independent variables: Exposure, Train maximum speed, road maximum speed, Area type (Urban or Rural), No of tracks, No of lanes, Whistle cessation, avg road gradient, track angle)

- Calibrate a **Negative Binomial Model** for each crossing type.



Standardized Reflective Crossing Sign (SRCS)

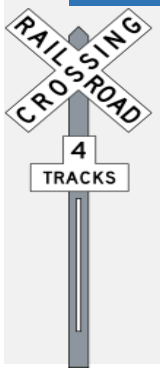
Signs with STOP

Flashing light with bell (FLB)

FLB with gates (FLBG)

Frequency Model Results

	Variables
-7.87	(Intercept)
0.517	log(Total Train * Total Vehicles)
0.012	Train Max Speed (kph)
0.011	Road Posted Speed (kph)
0.591	Urban area
	No of Tracks
	No of Lanes
	Whistle Cessation(Yes)
	Avg Road Gradient
	Urban*WhstleCessation
	Track Angle



	Variables
-5.81	(Intercept)
0.471	log(Total Train * Total Vehicles)
	Train Max Speed (kph)
	Road Posted Speed (kph)
	Urban area
	No of Tracks
	No of Lanes
	Whistle Cessation(Yes)
0.083	*Avg Road Gradient*
	Urban*WhstleCessation
	Track Angle

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Frequency Model Results

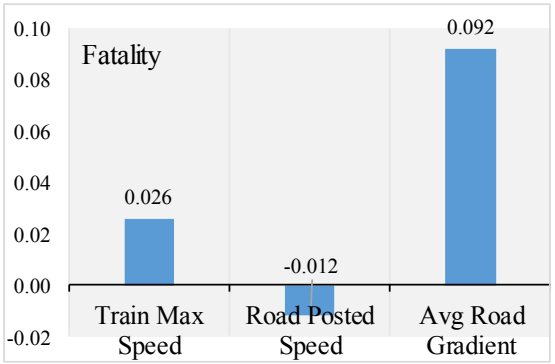
Variables	
-8.16	(Intercept)
0.276	log(Total Train * Total Vehicles)
0.013	Train Max Speed (kph)
0.014	Road Posted Speed (kph)
0.585	Urban area
0.274	No of Tracks
0.313	No of Lanes
0.808	Whistle Cessation(Yes)
	Avg Road Gradient
	Urban*WhstleCessation
	Track Angle

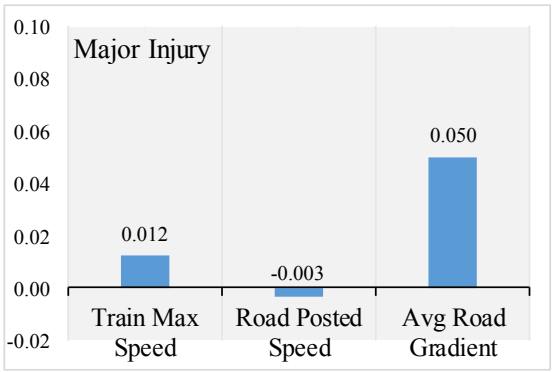
Variables	
-5.65	(Intercept)
0.325	log(Total Train * Total Vehicles)
	Train Max Speed (kph)
	Road Posted Speed (kph)
	Urban area
	No of Tracks
	No of Lanes
0.278	Whistle Cessation(Yes)
0.057	*Avg Road Gradient*
	Urban*WhstleCessation
	Track Angle

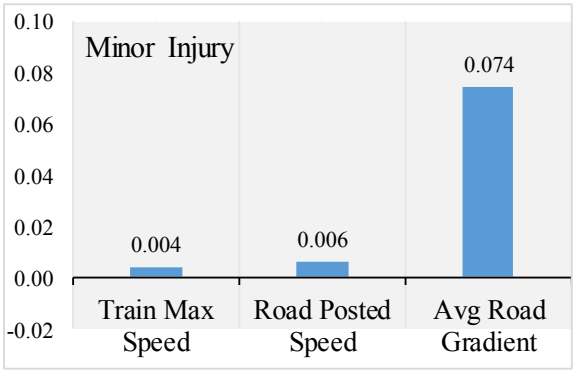
Severity Model

- 836 sample collisions from 2011to 2016: 110 are fatal collisions, 95 are major injuries, 122 are minor injuries and 509 are no injuries.
- Dependent variables:
  - Fatality
  - Major Injury
  - Minor Injury
  - No Injury (base condition)
- A multinomial logit model is calibrated

Results







Base condition: No Injury

Future Research

- Conduct before-after analysis to know safety effectiveness of new countermeasures
- Develop mathematical model for resource allocation
  - There are many crossings
  - There are many options for countermeasures
  - There is a limited budget

  Resource allocation model will help to find which countermeasure to implement at which crossings to maximize the safety benefits.

Thanks you!