Areas Prone to Car Collisions in the Greater Toronto Area

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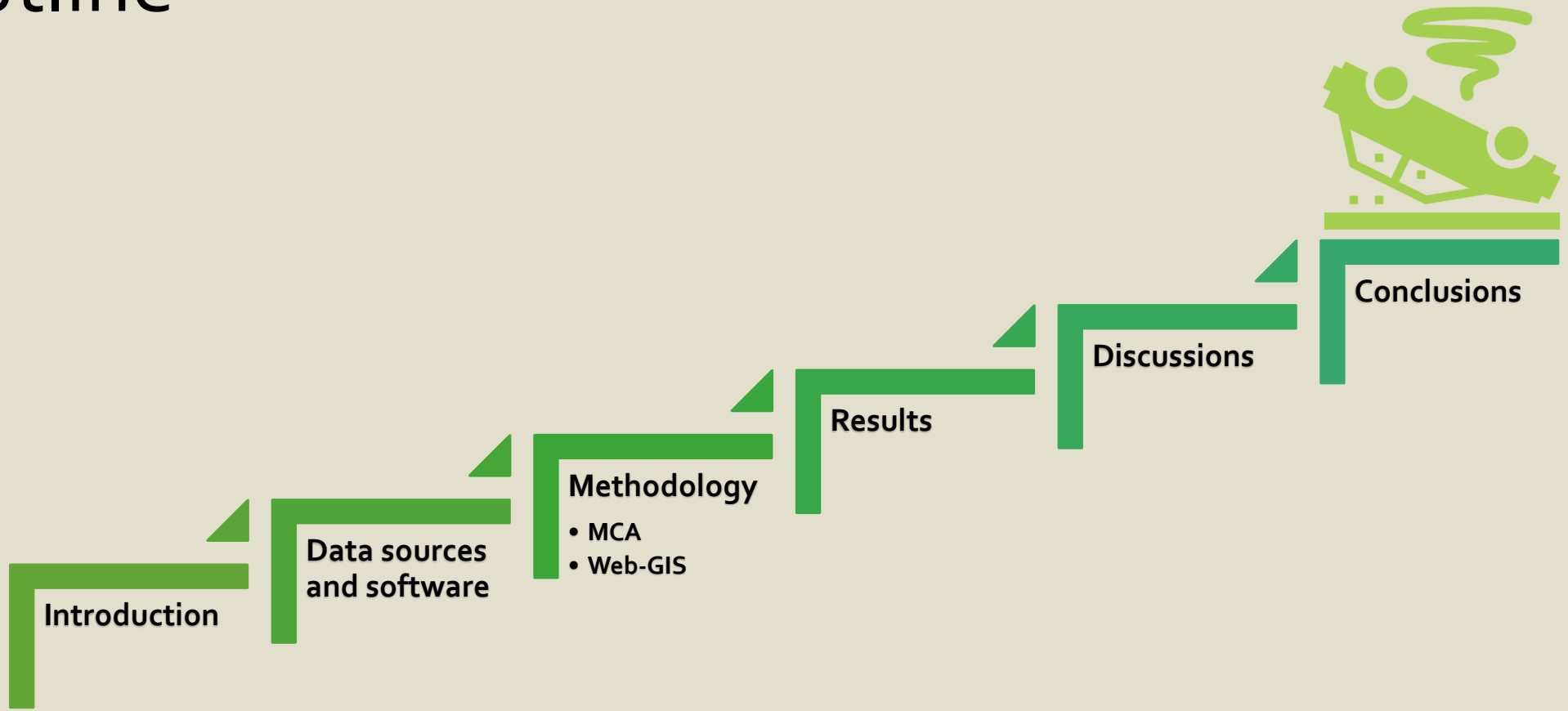
Outline



Car Accident by Hea Poh Lin from the Noun Project

Introduction

Background

Table 1 Distribution of fatal and non-fatal injuries by risk factor for 52,131 vehicles involved in collisions between 2001 and 2006 on Ontario's 400-series highways *(Continued)*

Environment			
Clear	549 (1.4)	39,598 (98.6)	40,147
Rain	45 (1.0)	4,567 (99.0)	4,612
Snow	82 (1.5)	5,354 (98.5)	5,436
Frozen Rain	23 (2.7)	842 (97.3)	865
Drifting Snow	55 (12.8)	375 (87.2)	430
Wind	10 (7.9)	117 (92.1)	127
Fog	16 (4.1)	372 (95.9)	388
Other	3 (2.4)	123 (97.6)	126

BMC Health

PERCENTAGE OF DRIVER AND PASSENGER FATALITIES AND SERIOUS INJURIES BY AGE GROUP 2015

	FATALITIES		SERIOUS INJURIES	
AGE GROUP (YRS)	**DRIVERS**	**PASSENGERS**	**DRIVERS**	**PASSENGERS**
0–4	0.0	4.7	0.0	3.1
5–14	0.0	5.6	0.0	7.5
15–19	7.1	10.6	7.7	15.3
20–24	11.5	15.6	12.5	14.5
25–34	18.2	10.3	19.9	15.7
35–44	10.7	10.3	17.0	9.5
45–54	16.1	8.4	16.3	8.4
55–64	14.6	13.9	13.3	8.3
65 +	21.8	20.1	13.2	12.6
NOT STATED	0.0	0.5	0.1	5.1
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**

Transport Canada's National Collision Database (NCDB)

Mission Statement

"To showcase collision vulnerability on highway sections within the Greater Toronto Area and road segments within the City of Toronto for different human-related and environmental factors."

https://commons.wikimedia.org/wiki/User:Lencer

Study Area

Data Sources

	Ontario Provincial Police	Toronto Police Service	Environment Canada
Location-related	highway segment location reference	collision location	weather station location
Human-related	driving action, driver condition, vehicle spacing, **color, gender,** etc.	driving action, driver condition, vehicle spacing, **driver age range,** etc.	
Environmental	time, lighting, weather types, **intersection, slope, curve,** etc.	time, lighting, weather types, etc.	**hourly temperature, visibility, humidity,** weather types, etc.

DMTI Spatial Incorporated: referenced highway segments and region boundary

City of Toronto: road network centerlines and city boundary

Software

Statistical Data

- R
- Excel
- Jupyter

Spatial Data

- ArcMap
- ArcGIS Pro
- QGIS

Web Development

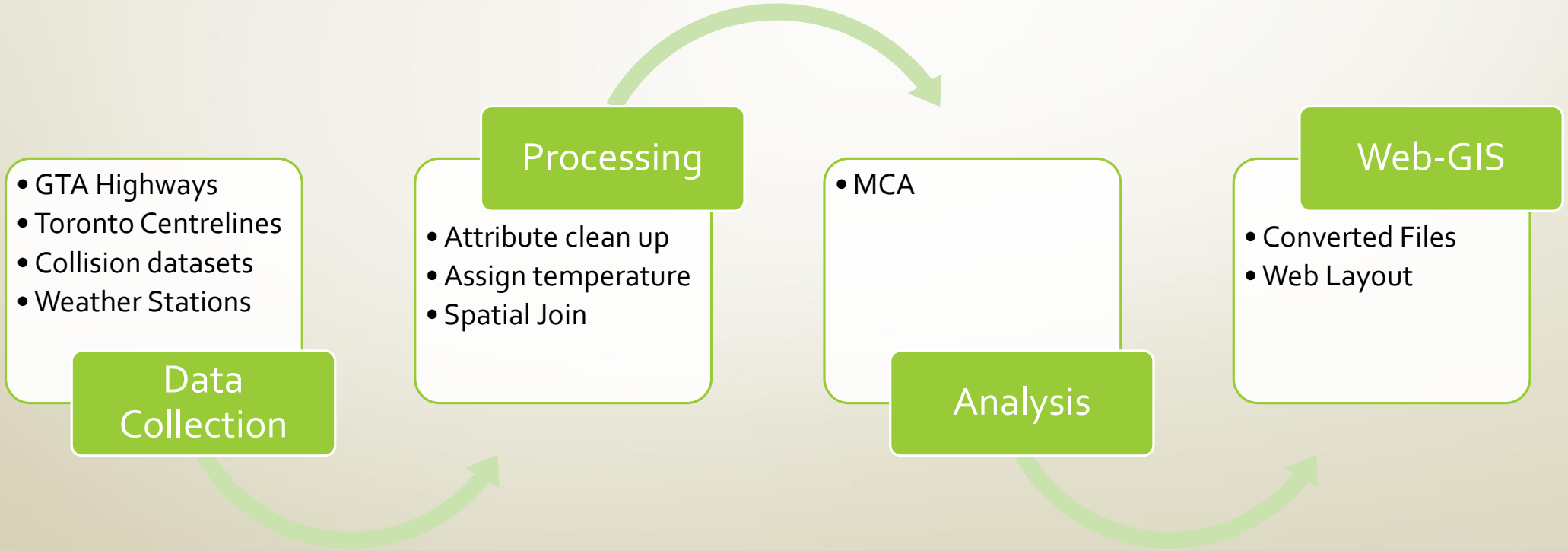
- Dreamweaver
- Leaflet

Efficiency Tools

- Notepad++
- Google Drive
- Microsoft Office 365

Methodology

Overview


• GTA Highways
• Toronto Centrelines
• Collision datasets
• Weather Stations
Data Collection
Processing
• Attribute clean up
• Assign temperature
• Spatial Join
• MCA
Analysis
Web-GIS
• Converted Files
• Web Layout

Multi-Criteria Analysis

Measure Collision Vulnerability:

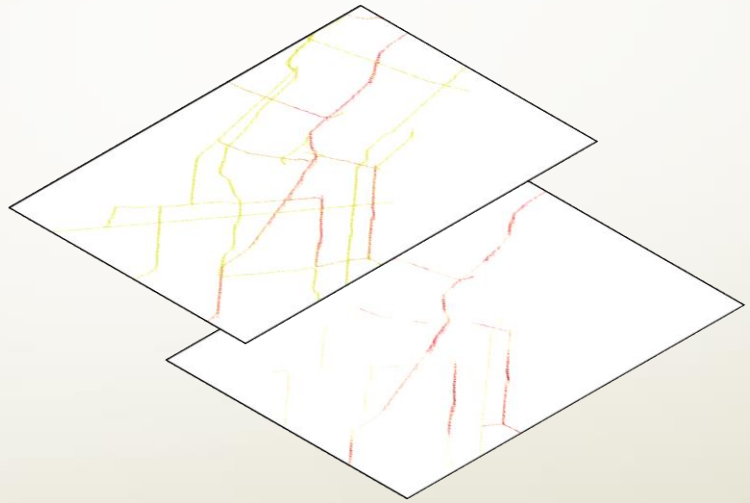
1. Criteria: over 40 factors

- Rainy
- Snowy
- Speeding
- …

2. Vulnerability Scores

3. Weights

4. Vulnerability Values



Research Unit: **Polyline**

Multi-Criteria Analysis

1. Select Criteria

   a. **Environmental Factors**: rain, snow…
   b. **Road Factors**: intersection, straight level…
   c. **Human Factors**: driver's age…
   d. **Driving Factors**: speeding, normal driving action…

2. Assign Vulnerability Scores

   a. Top 20% segments -> 100
   b. 20%-40% -> 80
   c. 40%-60% -> 60
   d. 60%-80% -> 40
   e. 80%-1000% -> 20
   f. No collision -> *O*

3. Decide Weights

- Use the number of historical accidents

Clear: 400	Speeding: 800	Age 65+: 700
Rain: 200	Normal: 700	Age 15-24: 100
Dawn: 700		

Scenario 1: Clear -> W = 0

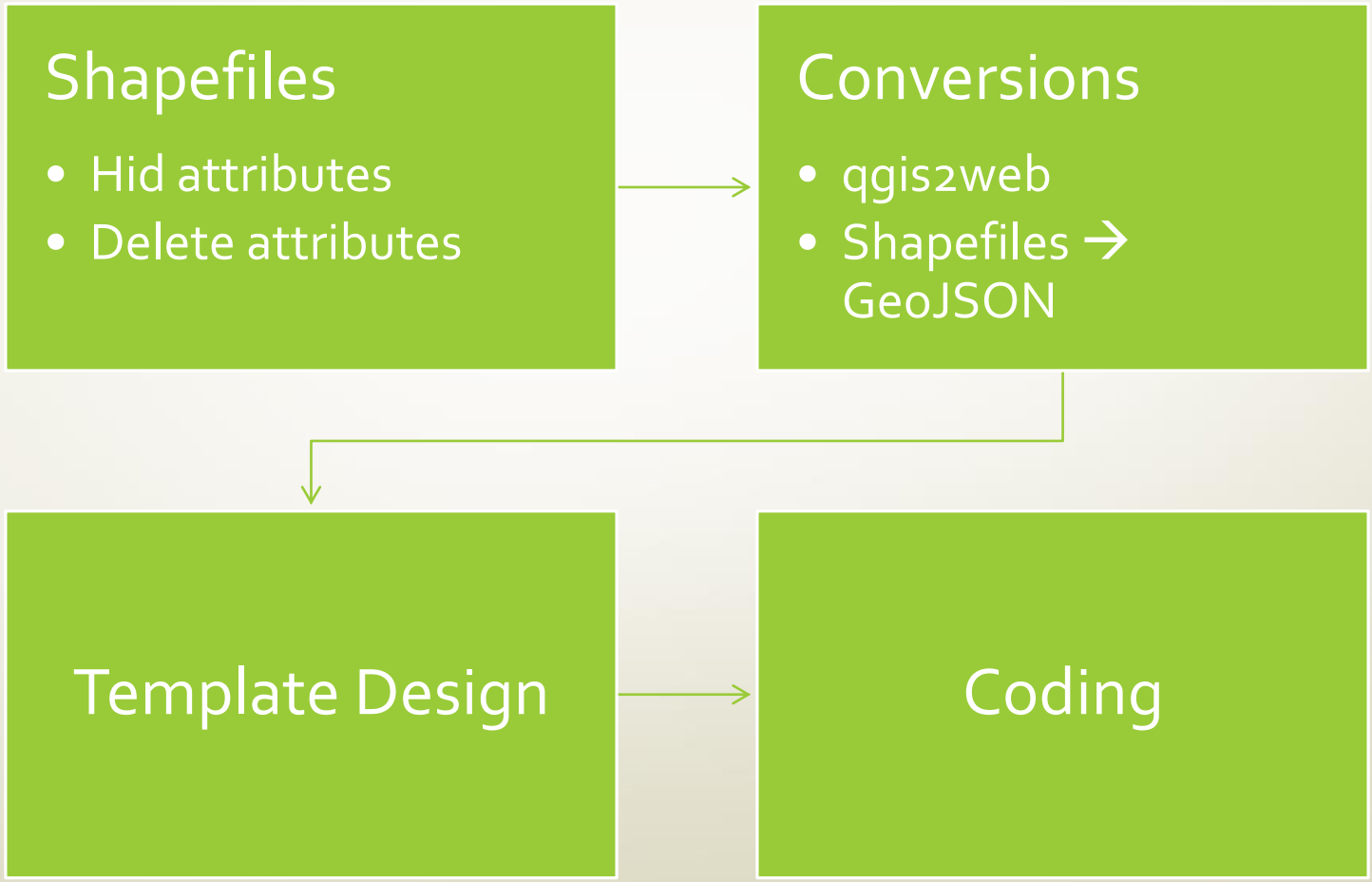
Scenario 2: Clear + Speeding -> W_c = 400 / (400 + 800);
W_s = 800 / (400 + 800);

Scenario 3: Clear + Speeding + Age 65+ ->
W_c = 400 / (400 + 800 + 700);
W_s = 800 / (400 + 800 + 700);
W_a = 700 / (400 + 800 + 700);

4. Calculate Vulnerability Values

- Weighted sum
- Loop for all scenarios

Web-GIS


Shapefiles
• Hid attributes
• Delete attributes
Conversions
• qgis2web
• Shapefiles → GeoJSON
Template Design
Coding

Results

Multi-Criteria Analysis

Selected Factors

Selected Factors in Highway		
environmental factor	**road factor**	**driving factor**
clear	non intersection	normal
daylight	straight level	proper action
snow		
dark		
dry surface		

Selected Factors in Toronto		
environmental factor	age	driving condition
clear	25-64	normal
dawn	15-24	speeding
rain	65+	

MCA

Calculated Scenarios

$$C_6^1 \times C_3^1 \times C_3^1 - 1 = 55$$

$$C_4^1 \times C_4^1 \times C_3^1 - 1 = 47$$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xhtml1-transitional.dt
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"text/html; c
ascii" />
<script type="te
javascript">
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if (navigator.app
'Netscape') {top.onresize = re
dom=document.
getElementById;
</script>
</head>
<body>

Web-GIS

Demo

Discussion

Statistics

- Criteria limited to the data provided
- Factors selected and weighted based on associated number of accidents
- Classification of segments vulnerability

Web-GIS

- Web map formatting issues
- Only displays data, cannot perform analyses
- Keeps highway and road data separate

Conclusion

- Collision frequency has not changed much over the years
- Many accidents occur from inattentive or reckless driving rather than poor road conditions
- Avoiding this will reduce collision vulnerability more

Questions