AASHTO 2024 SAFETY SUMMIT

A METHOD FOR SHORT-TERM NETWORK SCREENING

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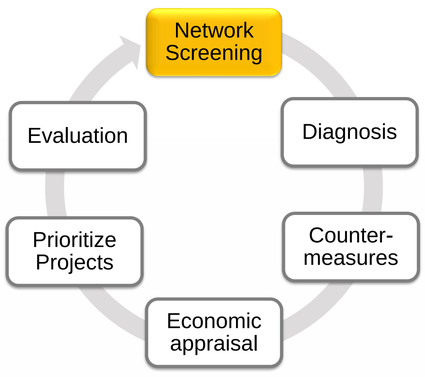
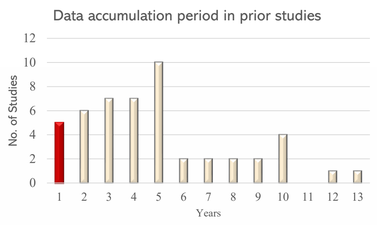
Background





- **Only five studies** were found on short-term network screening (from 49 studies)
- Safety countermeasures for short-term issues may be different from countermeasures for long-term issues
- Few publications with proper validation of the analysis method performance using future data.
- The goal of short-term network screening is to identify the road locations most likely to experience crashes in the next few weeks to months (not due to randomness)

Short-term Network Screening

- Low-cost interventions/enforcement
- Some crashes could be prevented earlier
- Designing effective countermeasures
- Specific reference group- Winter crash / Animal crash hotspots

Objective

- Develop a reliable framework for short-term network screening (i.e., identifying the locations most likely to have crashes in the near-term, not due to randomness)
- Explore the performance of the framework with proper validation

Concept

Weekly Crash Risk - 5%

In 20 weeks, number of weeks with 1 or more crashes - 2

High Probability

Not surprising when you observe a crash (expected)

Weekly Crash Risk - 2%

In 20 weeks, number of weeks with 1 or more crashes - 3

Low Probability

Not expected when you observe a crash

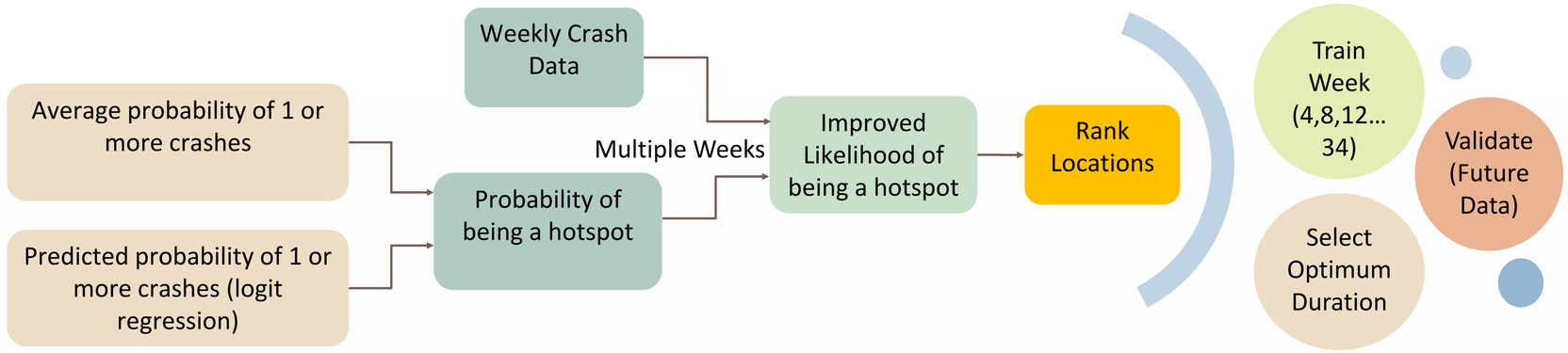
- What is the probability of observing 1 or more crashes on the road segment in any week?

Crash Hotspots

Low Probability & Observe Crashes Several Times in a Short Time Period, such as over a few months (unexpected)

Something unexpected likely causing crashes, the location may benefit from safety interventions: High

Methodology



P(A) = Probability of a location having high crash risk which is non-random in a particular week

P(B) = Probability of a location having high crash risk irrespective of randomness in a particular week

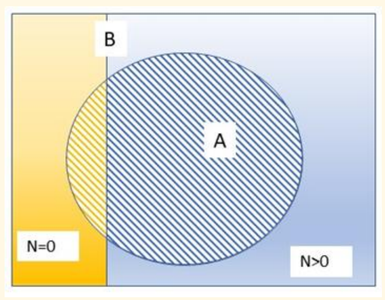
$$P(A) = P(A \cap B) = P(A|B)P(B)$$

$$P_{observed} = \frac{\sum y}{N}$$

$$P_{predicted} = \frac{\exp(\beta X)}{1 + \exp(\beta X)}$$

Binomial to normal approximation,

$$\frac{y_n - np}{\sqrt{np(1-np)}} \; for \; Y_n \sim Bin(n,p)$$



P(A|B) can be calculated from,

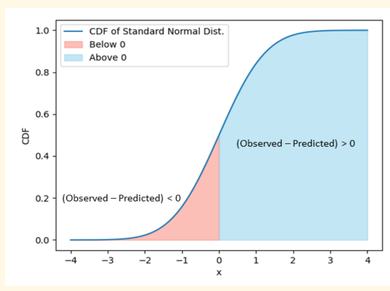
$$P(\ not\ randomly\ high | high) = \Phi\left(\frac{P(observed) - P(predicted)}{\sqrt{P(predicted)(1-P(predicted))}}\right)$$

- Given the observed outcomes and definition of 1 or more crashes making it a high crash location, we have for any week:

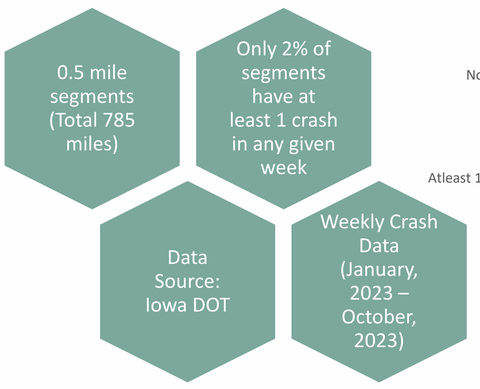
$$If\ Y = 0: P(\mathrm{B}) = P(\mathrm{predicted})$$
$$If\ Y > 0: P(\mathrm{B}) = 1$$

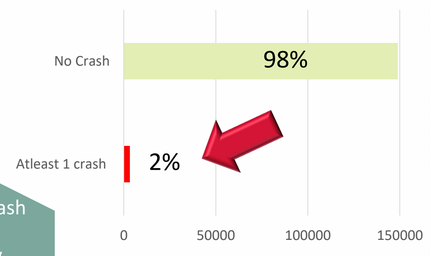
When we have multiple weeks,

$$\mathrm{P}(not\ randomly\ high \cap high) = \mathrm{P}(A \cap B) = \prod_{i=1}^{n} P(Ai \cap Bi)$$



Application: Interstates (Iowa, USA)





- Binary logit model
- If a segment has 1 or more weekly crashes, Y =1. For zero (0) weekly crashes, Y = 0.
- Model used 30 weeks of crash data

Validation Method

- **Train** Week- 4, 8, 12, 16, 20, 24, 28, and 30 weeks
- **Validation** 12 weeks
- **Rolling Average** of Crash Risk for different combinations of Train week
- Rank Correlation

Plot of crash counts in validation period

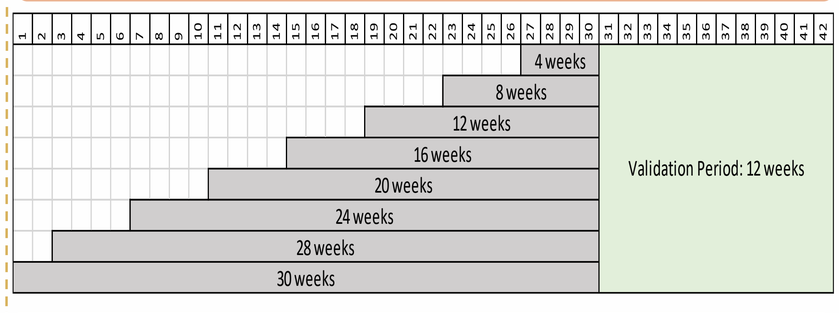
N_c = If the lower Rank has lower or equal crash count than previous rank

N_d = If the lower Rank has higher crash count than previous rank

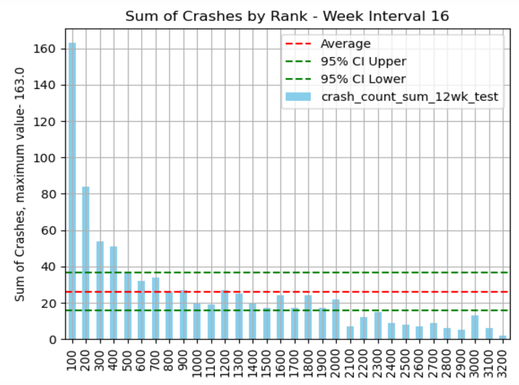
Rank (Hotspots)	Crash Count	# Concordant	# Discordant
1	4	-	-
2	3	1	0
3	3	2	0
4	5	2	1

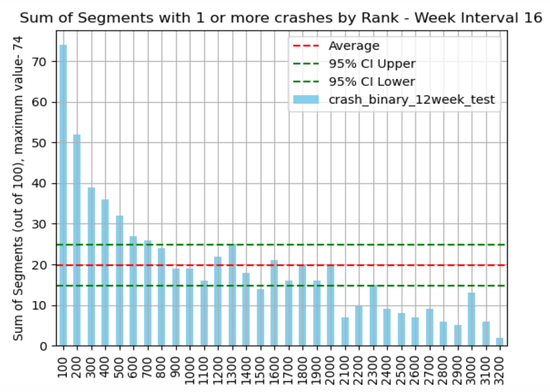
Correlation with Rank = $\frac{N_{c,adj} - N_d}{N_{c,adj} + N_d}$

Validation with Different Week Periods



Ranking Performance (Crash Risk Calculated from 16 weeks)

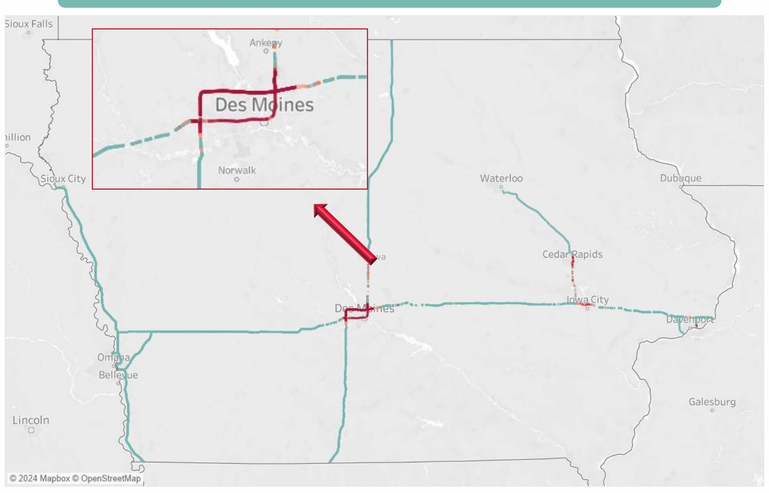




Start Week	End Week	Duration	correlation
1	30	30	0.809
3	30	28	0.809
11	30	20	0.809
7	30	24	0.809
15	30	16	0.807
19	30	12	0.805
23	30	8	0.805
27	30	4	0.804

Rank Correlation for Different Durations

Top 200 crash hotspots from 16 week period



Summary

- Created a reliable method for short-term crash hotspot detection (effectiveness confirmed through validation)
- Utilized a dataset where 98% of records indicated zero (0) crash occurrence.
- This method can be used to identify crash hotspots for rare crash events.

Limitations

- Closer investigation is needed to prioritize one hotspot above another
- Application to non-freeway locations is needed to determine optimal approach for different functional classes
- Additional applications (other geographical areas) would provide additional evidence of the validity of the method

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