COMPARISON OF PATTERN RECOGNITION-BASED HOTSPOT IDENTIFICATION METHODS BASED ON SIMULATION(20-02761)

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INTRODUCTION

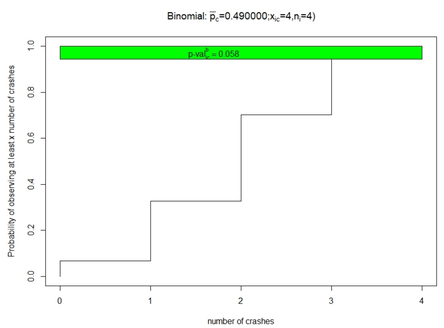
- Hotspot methods rely on SPFs
- Volume and infrastructure can be incomplete or unavailable
- Alternatively is to ascertain if there is a recurring crash pattern.
- We compares Binomial and Beta-Binomial methods for prioritizing hotspots in the absence of volume information and SPFs

METHOD: BINOMIAL TEST

Mean proportion of some crash type c: $\bar{p}_c = \frac{\sum_i x_{ic}}{\sum_i n_i}$

Probability of observing at least x_{ic} crashes of type c of n_i crashes:

$$\text{p-val}_{ic}^{b} = P(x \geq x_{ic}|n_i, \overline{p}) = 1 - P[x \leq (x_i - 1)]$$
$$= 1 - \sum_{x=0}^{x_{ic}-1} \frac{n_i}{x!\,(n_i - x)!} (\overline{p})^x (1 - \overline{p})^{n_i - x}$$



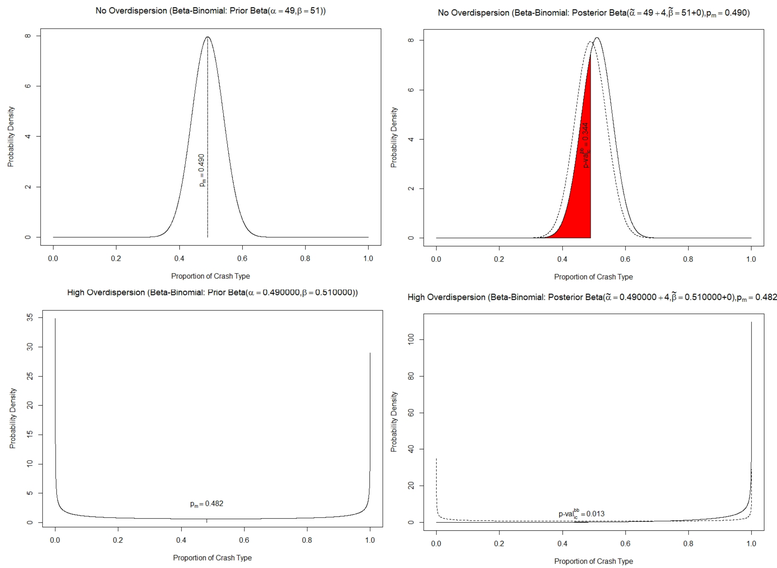
METHOD: BETA BINOMIAL TEST

Binomial distribution: $P(x_{ic}|p, n_i) = \binom{n_i}{x_{ic}} p^{x_{ic}} (1-p)^{n_i - x_{ic}}$

Beta prior: $p \sim Beta(\alpha, \beta).$

Estimate parameters and set threshold proportion: $\int_{p_m}^{1} Beta(p|\hat{\alpha}, \hat{\beta}) dp = 0.5$

Calculate p value: $\text{p-val}_{ic}^{bb} = 1 - P(p_i > p_m|x_{ic}, n_i) = Beta\left(p_m, \tilde{\alpha}, \tilde{\beta}\right)$

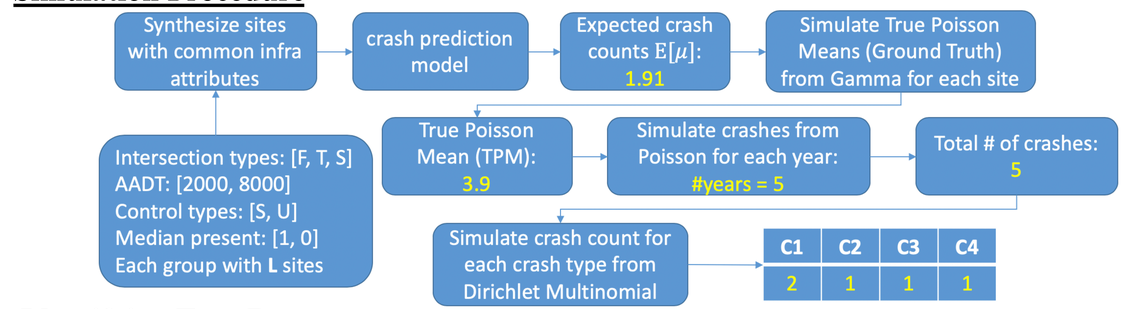


COMPARISON OF TWO METHODS

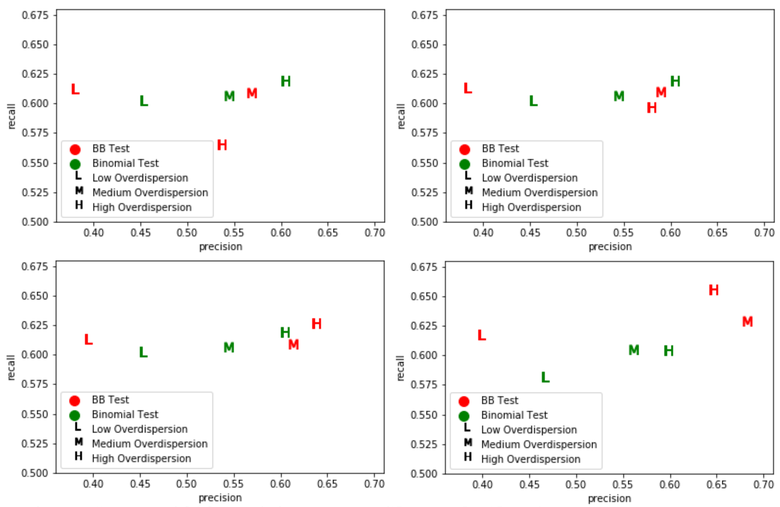
- Binomial distribution does not account for overdispersion in crash proportions
- Binomial test evaluates the exceedance of the observed crashes of a given type observed at a specific site relative to the mean crash proportion in the reference population
- Beta-Binomial test evaluates the median crash proportion in the reference population relative to the EB-adjusted crash proportion of a specific site.

SIMULATION STUDY

Simulation Procedure



Identifying True Patterns



$$\text{precision} = \frac{\text{True Positive}}{\text{Predicted Positive}}$$

$$\text{recall} = \frac{\text{True Positive}}{\text{Actual Positive}}$$

- 75-percentile proportion is better in Beta-Binomial test
- Beta-Binomial test is better in medium and high overdispersion cases
- Beta-Binomial test is better as the number of crashes increases

1) p_{medium} 2) p_{mean}
3) p_{75} 4) 5-time TPM, p_{75}

Ranking HCCLs (Pearson Correlation)

Dispersion	Low	Medium	High
Binomial Test	0.62	0.63	0.66
Beta-Binomial	0.58	0.61	0.62

Two methods perform similar

DISCUSSION

- Beta Binomial performs better in hotspot with motor vehicle crashes as more crashes are included
- Pattern recognition is needed even in the presence of SPFs as the detection of an underlying crash dynamic may aid in the identification of appropriate countermeasures

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This research was funded by California Department of Transportation
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