Ranking Restaurant Chains using Poisson Regression

"CBC Marketplace" on CBC Television, April 2014

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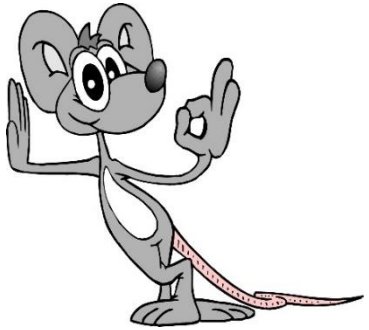
The Problem



- Rank restaurant chains by food safety compliance
- Inspection reports on the number of major violations found during each inspection in 2013
  - Data from 5 Canadian cities
  - Inspectors use different standards in different cities
  - Average food safety levels may be different in different cities
- Need to quantify uncertainty

The Dataset (1)

- Data on food safety **inspections** of 100 of **stores** of 13 **chains** in 5 Canadian cities for 2013
- Approx. 3 inspections per store
- Number of major violations is recorded

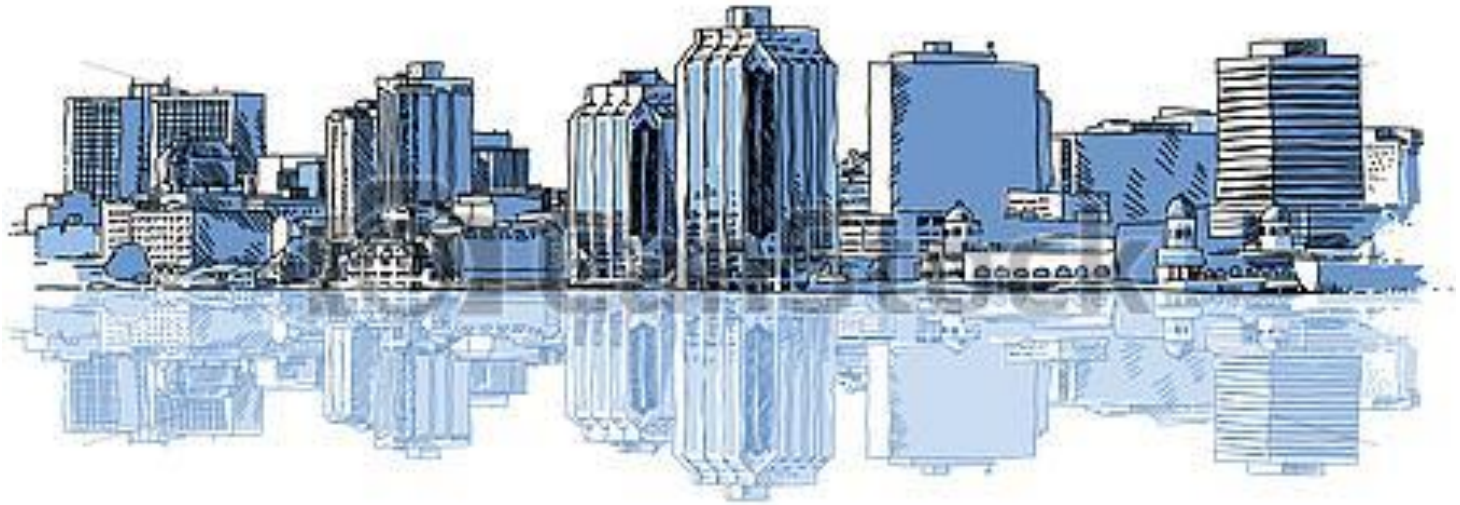
1	Chain	Addr	Store	Report nc	Purpos	Date	Total Significant	TOTAL CRUCIAL	TEMPERATURE	FOOD HANDLING /HAND WASHING	KITCHEN CLEANLINESS	PEST CONTROL	CROSS-CONTAMINATION
2	Tim Hortons	2X2	T-T1	1	Routine	14-Mar-13	0						
3	Tim Hortons	2X2	T-T1	2	Routine	14-Mar-13	0						
4	Tim Hortons	2X2	T-T1	3	Routine	14-Dec-12	0						
5	Tim Hortons	6C7	T-T2	1	Routine	2-Oct-13	0						
6	Tim Hortons	6C7	T-T2	2	Routine	23-Jan-13	1				1		
7	Tim Hortons	6C7	T-T2	3	Routine	17-Sep-12	0						
8	Tim Hortons	0B6	T-T3	1	Routine	12-Jun-13	0						

The Dataset (2)

- (Very) different rates of violations in different cities
  - Rates of “major” violations differ by up to a factor of 4
  - Different standards in different cities?
- The numbers for Vancouver were assigned by an expert based on narrative inspection reports
- 2024 reports for Toronto, 1279 for Calgary, 877 for Ottawa, 472 for Vancouver, 118 for Regina

Ranking Chains in a Single City

- For each chain, compute the average/expected number of major violations found per inspection
- Standard errors are easily obtained
  - Use either linear regression or Poisson regression



Halifax

Combining Data From Multiple Cities

- Data from Toronto, Vancouver, Calgary, Ottawa, and Regina
- The average number of violations per inspection differs by as much as a factor of four in different cities
  - Inspectors use different standards?
  - (Different average levels of compliance?)

Toronto *Ottawa* *Vancouver* *Calgary*

Ranking Measure

- Important to rank using a comprehensible measure!
- Rank by the *expected number of violations (using Toronto standards)* in a location of a given chain
- “If I visit a location of chain C, how many violations can I expect to encounter?”

Quasi-Poisson Regression:

$$N_{violations} \sim Poisson(\exp(c + a_{chain} + b_{city}))$$

- Unit of analysis: a single inspection visit
  - A random Canadian deciding where to go for lunch
- Model the expected number of violations as
  - $E(N_{violations}) = \exp(c + a_{chain} + b_{city})$ ← log link fn
  - The larger a_{chain} , the more violations are assigned to ***chain***
  - The larger b_{city}, the more violations inspectors assign in ***city***
  - They combine multiplicatively, which makes sense

$$E(N_{violations}) = \exp(c + a_{chain} + b_{city})$$

- Rank by the number of violations that would be assigned in Toronto, based on all of the data:

  $\exp(c + a_{chain} + b_{toronto})$

  - The same as ranking by a_{chain}
  - "Expected number of violations using Toronto standards"
  - Standard errors for the *a* can be obtained by running quasi-Poisson regression on the data
    - Enables us to quantify uncertainty in the ranking
    - Standard errors adjusted for multiple comparisons using Tukey's Honest Significant Differences

	Major violations per inspection (adjusted to Toronto level) Non-adjusted figures given in square brackets	per 10	per 100	Worse than
Starbucks	0.11 (69.59/652) [153/652 non-adj.]	1	11	
KFC	0.13 (29.43/225) [44/225 non-adj.]	1	13	
A&W	0.17 (35.19/202) [86/202 non-adj.]	2	17	
Subway	0.18 (196.52/1087) [327/1087 non-adj.]	2	18	Starbucks
Pizza Hut	0.20 (29.20/147) [53/147 non-adj.]	2	20	
Tim Hortons	0.21 (213.06/994) [312/994 non-adj.]	2	21	Starbucks
Swiss Chalet	0.29 (66.48/229) [78/229 non-adj.]	3	29	KFC, Starbucks
Wendy's	0.30 (50.51/168) [83/168 non-adj.]	3	30	KFC, Starbucks, Subway
McDonald's	0.33 (160.46/487) [267/487 non-adj.]	3	33	A&W, KFC, Starbucks, Subway, Tim Hortons
Boston Pizza	0.36 (61.08/171) [117/171 non-adj.]	4	36	A&W, KFC, Starbucks, Subway, Tim Hortons
The Keg	0.37 (20.29/55) [32/55 non-adj.]	4		KFC, Starbucks
Second Cup	0.40 (105.70/263) [138/263 non-adj.]	4	40	A&W, KFC, Pizza Hut, Starbucks, Subway, Tim Hortons
Moxie's	0.49 (50.18/103) [104/103 non-adj.]	5	49	A&W, KFC, Pizza Hut, Starbucks, Subway, Tim Hortons

Table 4. Nationwide ranking: chains ranked by major violations per inspection, and the chains which are better than the given chain with 95% confidence. We report the estimated number of violations per inspection that would be assigned by Toronto inspectors to a location of a given chain. .

Report a set of significant differences at 95% confidence