New York Restaurant Guide

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Food Safety Inspection Analysis and Machine Learning

Welcome to the New York Restaurant Guide,
An analysis of Food Safety inspections and machine learning model

Today's Fare:

Department of Health Inspection Data
- Public Data provided by New York Open Data
- 3 year period from mid 2016 to mid 2019
- Scored and Graded inspections for food safety
  - A < 13 points

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Gratis

The New York City Department of Health and Mental Hygiene make regular inspections of all restaurants in New York City and approximately 3 years of results are made publicly available through the New York Open Data Project
Food Safety Inspections are scored based on the number and type of health code violations and grade is awarded. A score of 13 or less is awarded an A grade.

Prix Fixe Menu

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First Course
Initial Inspection analysis

Second Course
Selection of 3 - Location, Type, History

Third Course
Selection of 2 - Classifier Models

Dessert
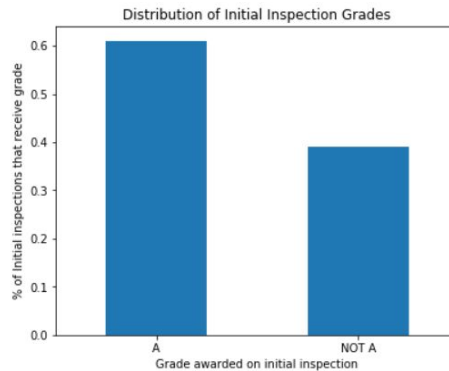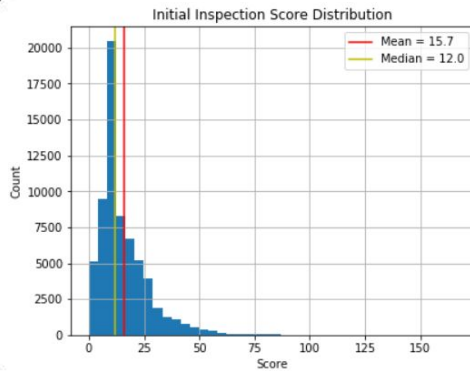Conclusions & Business Recommendations
Future Work

The meal this evening consists of an analysis of inspections results, scores and violations

This is followed by a deconstruction of the restaurant characteristics into 3 categories, it's location, type and history and their relationship with score and grade

Next are predictive grade classifier models available in 2 constructions

We finish with conclusions and business recommendations and a discussion of future work

First Course

Initial Inspection Score Distribution
Mean = 15.7
Median = 12.0

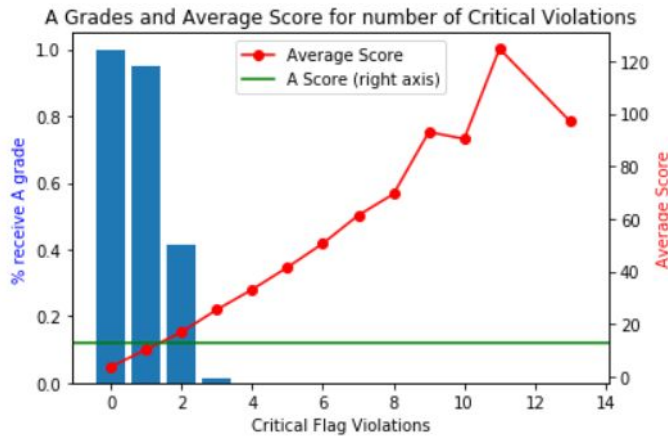**Distribution of Initial Inspection Grades**

60% of initial inspections receive an A grade

Initial inspection scores follow an approximately normal distribution with a left skew and long tail that drags up the mean.
Approximately 60% of all initial inspections receive an A grade

First Course

A Grades and Average Score for number of Critical Violations

1 Critical flag violation "allowable" for A

Critical flag violations present a serious risk to public health but a single violation will not get you shut down
95% of inspections that were cited for 1 critical violation were awarded an A grade
2 violations this number drops to 40%
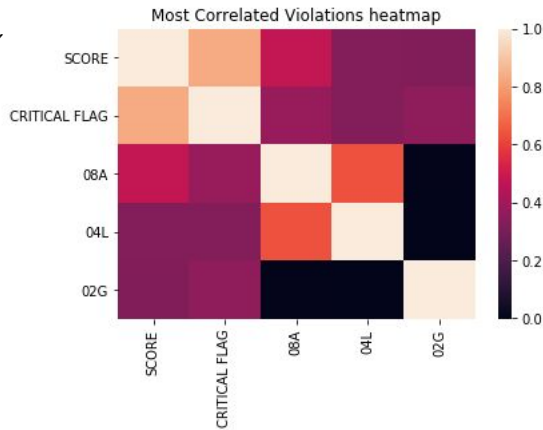Any more and it is virtually impossible to achieve an A

First Course

Correlation > 0.3

Critical Flags and Score

08A - Vermin Proofing

04L - Mice

02G - Cold food > 41 deg F

Most Correlated Violations heatmap

The heaviest correlation with inspection score is with the number of critical violations as these are codependent variables

Next is a lack of sufficient vermin proofing in the establishment which is NOT a critical violation

Evidence of mice is the most common form of vermin cited by inspectors

Inadequate refrigeration of cold food items can cause serious illness and is scored highly for individual violations
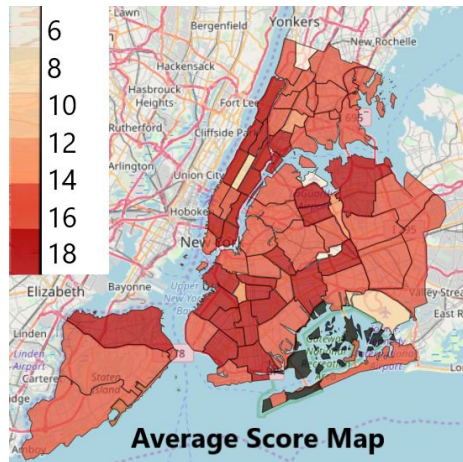
Second Course

Community Boards
Highest Density in Midtown and Lower Manhattan

| 1 | 348 | 694 | 1041 | 1387 | 1734 | 2080 |
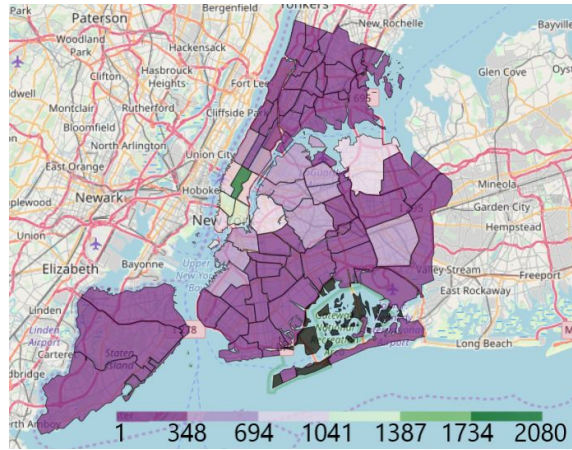
New York City is divided up into 69 Community Board Areas
The highest density of restaurants is found in Midtown and Lower Manhattan

Second Course

Community Boards
Average Inspection Score By Community Board

Average Score Map

The average inspection score by community board can be used to paint a picture of food safety standards across New York
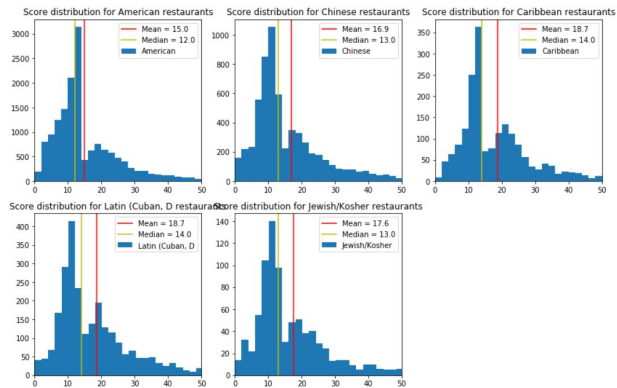
Second Course

Cuisine Style
Average Inspection Score
Distribution by Cuisine Style
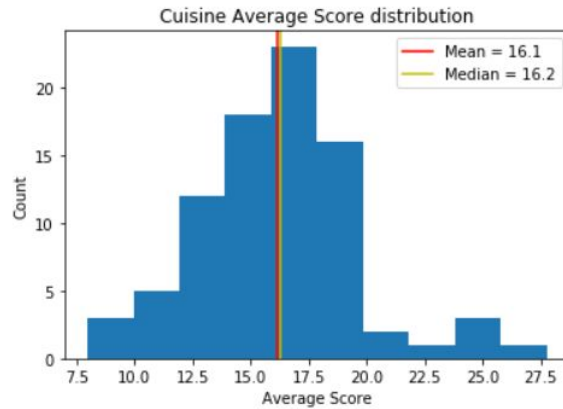
The relationship between cuisine style and score also follows an approximately normal distribution with certain cuisine styles much more easily able to consistently achieve a lower inspection score and others struggling

Second Course

Cuisine Style
Bimodal Score Distribution
Within Popular Cuisine Styles

The most popular cuisine styles with many inspection data points show a bimodal distribution.
Inspectors use their judgement or owners apply pressure and there is some hesitancy to give score that just misses an A

Second Course

Chain
Restaurants Belonging to Chains Have a Lower Average Score

**Score distribution for chain and not chain restaurants WITHOUT outliers**
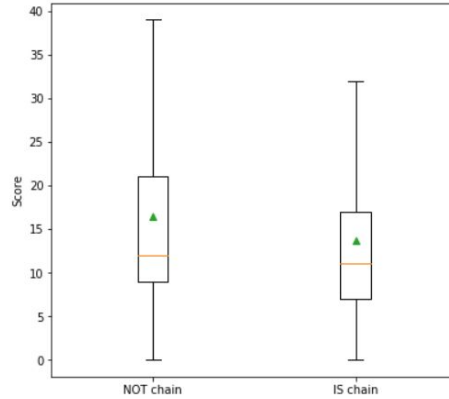
Chains with more than one outlet operating under the same business name are most able to score lower on their inspection. Larger chains often have strict training programs and have very clear processes based around food safety.

Second Course

History
Improvement and disimprovement equally likely

Dramatically bad scores do not happen again

Scatter plot of Inspection Score vs Previous Inspection Score
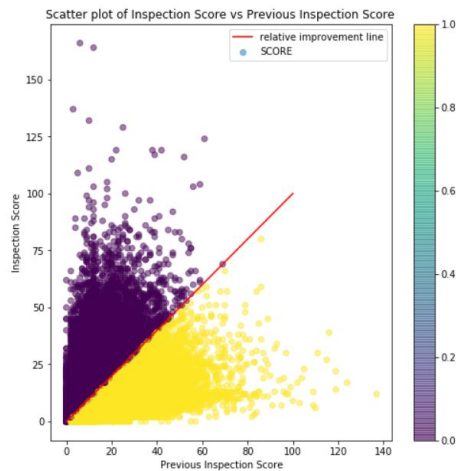
Restaurants both improve and disimprove over the course of multiple inspections but dramatically bad scores are addressed seriously by the Dept of Health and process changes are enforced. They do not happen again

Second Course

History
A Rated Restaurants Most Commonly Maintain Their A

Improvement and Disimprovement Possible and Commonplace

Consistent Performers

A → **17510** A

Disimprovers → 7649

Improvers

Not A → **8675** Not A

→ 10060
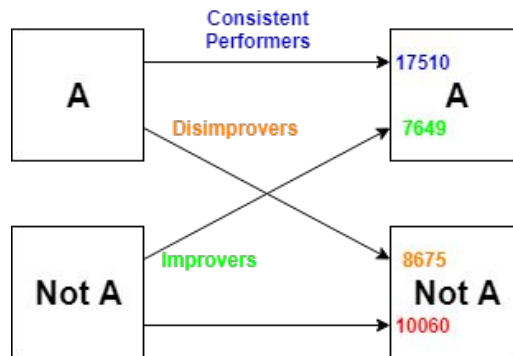
An A is the most common inspection outcome and restaurants that achieve an A will usually maintain that A through the next inspection cycle but a significant portion do not its is not possibly rest on the laurels of a successful A. Likewise a significant portion of restaurants that do not achieve an A use that as an impetus to improve and achieve an A on their next inspection.

Third Course

Categorical Matrix
Cuisine and Community Board
One-Hot Encoded

156 Features

```
              precision    recall  f1-score   support

      False       0.69      0.66      0.67      5110
       True       0.68      0.71      0.69      5149

   accuracy                           0.68     10259
  macro avg       0.68      0.68      0.68     10259
weighted avg       0.68      0.68      0.68     10259
```


Confusion Matrix: XGBoost Resampled
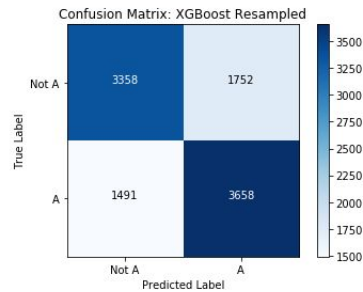
Using features from the 3 characteristics above 2 machine learning classifiers were created
The first uses one hot encoding of categorical features for community board and cuisine style to create a large sparse matrix with 156 columns consisting mostly of zeros
An accuracy rate of 68% is achieved at predicting an A grade

Third Course

	precision	recall	f1-score	support
False	0.68	0.64	0.66	6368
True	0.67	0.70	0.68	6456
accuracy			0.67	12824
macro avg	0.67	0.67	0.67	12824
weighted avg	0.67	0.67	0.67	12824

Summary Statistics Matrix

Cuisine and Community Board Features Using Mean, Standard Deviation and Count

9 Features

Much Faster Training

Confusion Matrix: XGBoost (Scaled & Resampled)
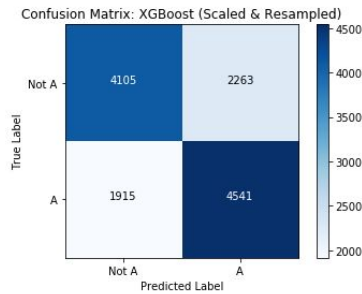
The second classifier uses the mean, standard deviation and count for each of the categories within cuisine style and community board to create numerical features and is a much smaller matrix. This classifier achieved an accuracy of 67% in one tenth of the training time for the optimised classifier

Dessert

"At Risk"
Forewarned is Forearmed

Restaurant Consultants
Identifying potential clients

Advance knowledge of the expected inspection grade allows restaurateurs to identify their risk of not receiving an A and restaurant consultants to identify those same establishments where their services will be the most useful. 88% of New Yorkers are influenced by posted inspection grades when choosing where to dine. Getting an A matters.

Dessert

More Data
Inspections Happen Every Day

Time Series Analysis
Seasonal Effect Observed

Variable History
None Or More Than One Past Inspection

The classifier models can be improved by more data. Inspections happen every single day and the Open Data database updates daily

Time of year effects are not considered in this analysis or this model but may be observed

Inspection history is considered only to a depth of one inspection, many restaurants have been operating for several years and have a much deeper inspection history that is not taken into account. Similarly new restaurants that have not had a previous health inspection since opening are not able to be considered in the classifier model.

Thank You!

Please Tip Your Server

20% Gratuity Applied to Parties of 6 or More

Thank you for dining with us this evening!