# NYC PUBLIC SCHOOLS: WHAT CAN THE COLLEGE READINESS INDEX TEACH US?

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GA - DAT30

Final Presentation – March 16, 2016

# THE ISSUE

- Although graduation rates in NYC public schools have risen over the years, the rate of students prepared for college has remained low (73% vs 29% on average, from my data)
- Thus, NYC public schools are graduating many students each year who are not considered college-ready
- **QUESTION**: Can we predict which schools are graduating college-ready students at a rate above NYC's average graduation rate *(within one standard deviation)?* ← High-performing schools


DAILY NEWS | NEW YORK | NEWS | POLITICS | SPORTS | ENTERTAINMENT

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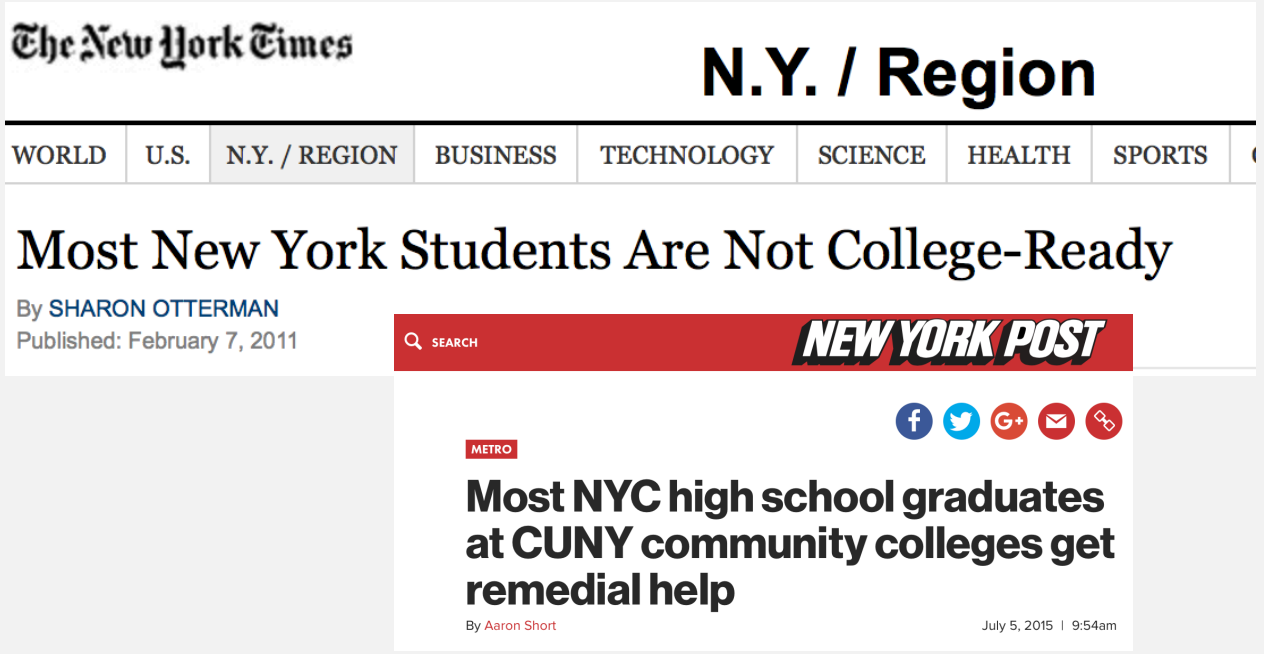
**School grades: Department of Education data show less than a third of New York City high school students are college-ready**

**City Education Department releases A's to F's for city high schools; numbers are up to 29% from 25% last year**

BY BEN CHAPMAN, VERA CHINESE, RACHEL MONAHAN / NEW YORK DAILY NEWS /

Updated: Tuesday, November 27, 2012, 1:19 AM

A A A


The New York Times

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Most New York Students Are Not College-Ready

By SHARON OTTERMAN

Published: February 7, 2011

SEARCH NEW YORK POST

METRO

**Most NYC high school graduates at CUNY community colleges get remedial help**

By Aaron Short

July 5, 2015 | 9:54am

# KEY BACKGROUND INFO ON THE DATA

- Data gathered from NYC Open Data website and the NYC Department of Education website over past two school years
  - Ever since de Blasio administration changed school evaluation methods
- Data summarizes schools – NOT info on individual students
- College Readiness Index (CRI)
  - Percentage of students who meet CUNY's standards of readiness in math and English based on test scores (Regents, SATs, APs)
  - Derived cut-off scores based on students needing to enroll in remedial classes in CUNY community colleges (found boundary)
    - 75% of enrollees in 2011[1]
  - NYC public schools are some of the most racially and socioeconomically segregated schools in the nation[2]

[1] FODERARO, Lisa W. "CUNY Adjusts Amid Tide of Remedial Students." The New York Times, 3 Mar. 2011.
[2] Wong, Alia. "How to Solve the Diversity Problem at NYC's Public Schools." The Atlantic, 5 Mar. 2015.

# HYPOTHESIS

- Schools with large populations of historically privileged groups will graduate students who are college-ready at a higher rate than schools with large amounts of populations that have been historically marginalized or have experienced structural inequalities.

# PEAK AT THE DATA

- Mostly measurable characteristics of NYC public high schools (performance, demographics, location, etc.):
  - 2013_2014_HS_SQR_Results_2015_03_02.xlsx
  - 2014_2015_HS_SQR_Results_2016_01_07.xlsx
  - DemographicSnapshot201011to201415Public_FINAL-2.xlsx
  - 2015 Graduation_Rates_Public_School-2.xlsx- DOE_High_School_Directory_2013-2014.csv
  - DOE_High_School_Directory_2014-2015.csv- 2014 Public Data File SUPPRESSED.xlsx
  - 2015 Public Data File.xlsx- Location_Information_Report.csv
  - seven_major_felony_offenses_by_precinct_2000_2014.xls
  - violation-offenses-by-precinct_2000-2014.xls
  - Zip_MedianValuePerSqft_AllHomes.csv

```
data.shape
(975, 51)
```

| male_percent | poverty_percent | avg_home_value_sqft | district_admin_code | grade8_english | grade8_math | regents_algebra | regents_english | regent |
|---|---|---|---|---|---|---|---|---|
| 0.623529 | 0.866667 | 1321.166667 | 1 | 2.18 | 2.06 | 64 | 66 | 53 |
| 0.621711 | 0.891447 | 1321.166667 | 1 | 2.27 | 2.37 | 64 | 69 | 67 |
| 0.530030 | 0.735736 | 1324.500000 | 1 | 2.66 | 2.63 | 65 | 75 | 64 |
| 0.432507 | 0.845730 | 1321.166667 | 1 | 2.28 | 2.09 | 61 | 69 | 63 |
| 0.484726 | 0.273199 | 1321.166667 | 1 | 3.50 | 3.53 | 80 | 91 | 87 |

# PRE-PROCESSING

- Dropped and imputed missing values
- Feature Selection – Necessary due to overlapping features in sources as well as presence of irrelevant features
- Feature Engineering:
  - Length of School Day (End of day – Start of day)
  - Diversity Score (Sum of the squared reported race/ethnicity percents [black, white, Hispanic, Asian]
    - Scaled since percent sums not always equal to 100%
    - .25 = Most Diversity | 1 = Least Diversity/Most Homogeny
  - Overall SAT score (Reading SAT + Writing SAT + Math SAT average scores)
  - Overall Regents score (Algebra + English + Living Environment + Global History Regents average scores)
  - Grade 8 Proficiency score (Grade 8 Math + Grade 8 English scores)
  - All Crime (Major crimes + violation offenses)
- Tidied the names
- Dummy categorization (separately)
  - Zip codes
  - Administrative Districts

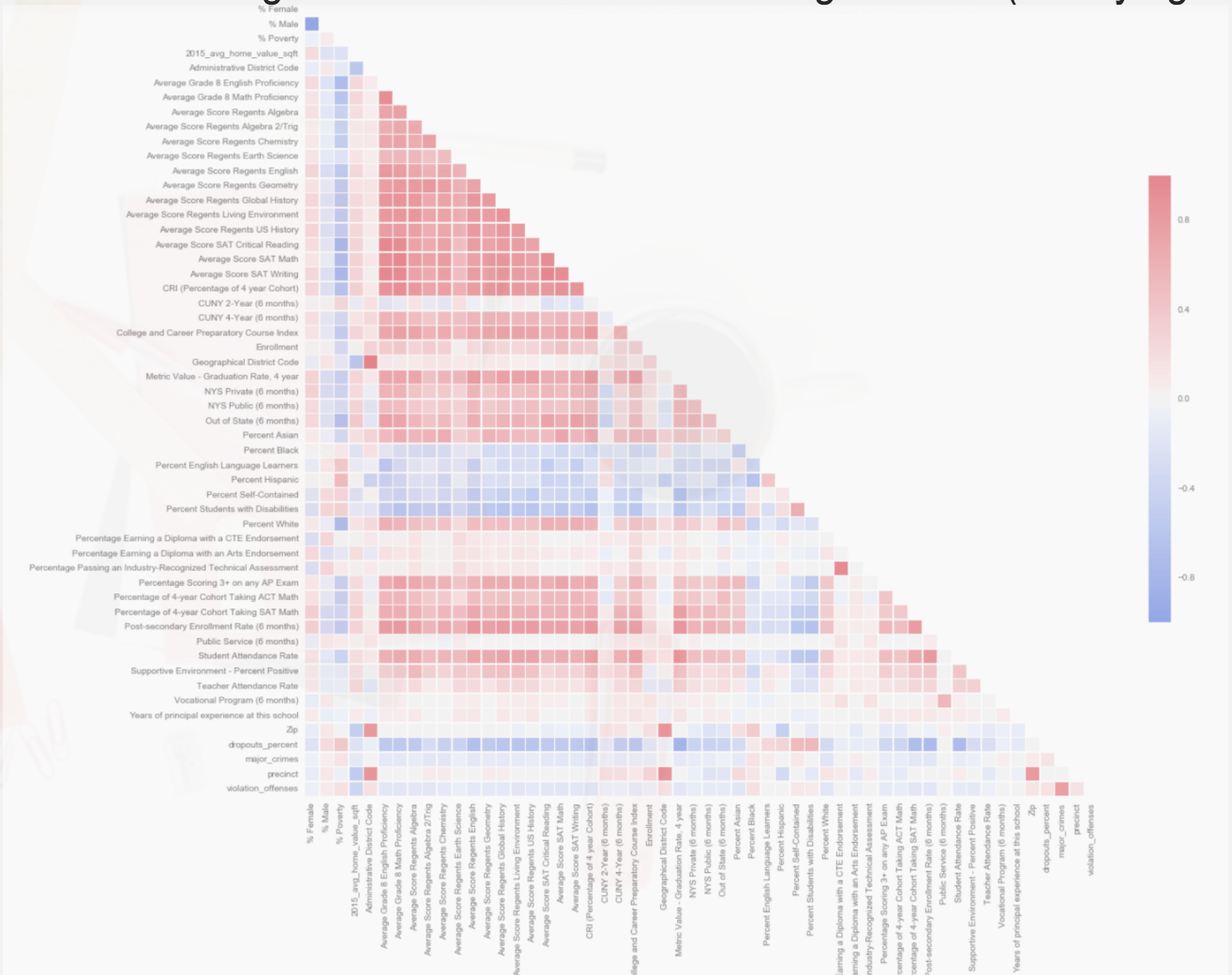
# FEATURE SELECTION

- Created visuals to look at correlation (heatmap) → Removed highly correlated features (ex: many Regents exams)
- Created visuals to view missing values → Removed those missing 50%+ (ex: pupil-teacher-ratio)
- Viewed feature variance → removed those with lowest variance (ex: Public Service percentage attendance)
- In the end, removed features directly related to the response variable due to leakage
  - Graduation Rate
  - College-Readiness Index (CRI) (and the highly-correlated college and career readiness index)
  - Test scores related to the CRI: all SAT scores, all Regents values, percentage of students scoring 3+ on AP exam
- Also removed forward-looking features (post-secondary enrollment rate and related indicators)
- Created four different datasets for modeling:

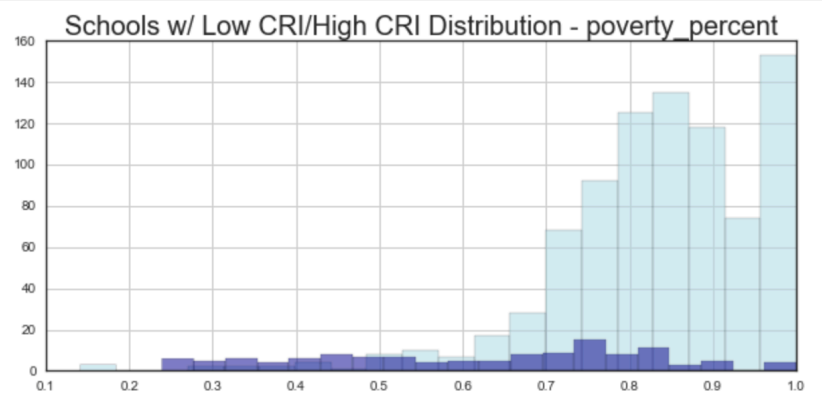
| DataFrame Name | Description | Number of Features |
|---|---|---|
| data_noexam | Base | 30 |
| data_admin | Contains administrative district codes + base | 63 |
| data_zip | Contains zip codes + base | 151 |
| data_rses | Contains only features directly related to hypothesis | 12 |

# OBSERVATIONS

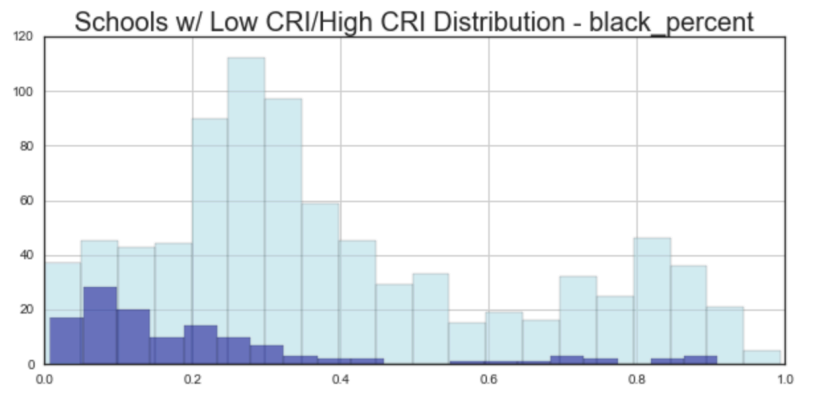
- High school's graduation rate and college readiness index share high correlation with the following features (in varying strengths):
  - Post-Secondary enrollment rate
  - Student Attendance Rate
  - Percentage of students who take the SAT
  - Grade 8 Proficiency Scores
  - Poverty and Disability (Negatively correlated)



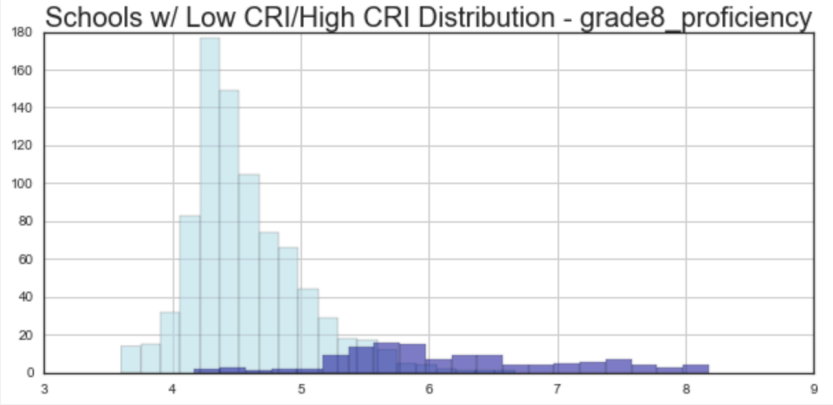
# OBSERVATIONS (CONT'D)



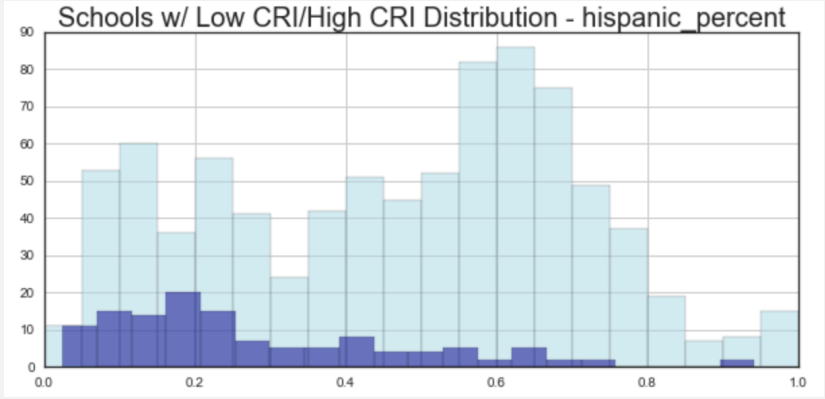

Median=Dataset: 83% | Low CRI: 84% | High CRI: 66%



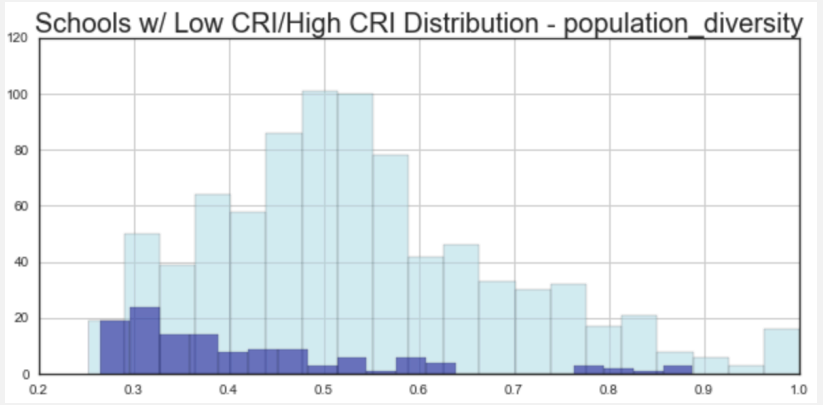

Median=Dataset: 30% | Low CRI: 32% | High CRI: 14%



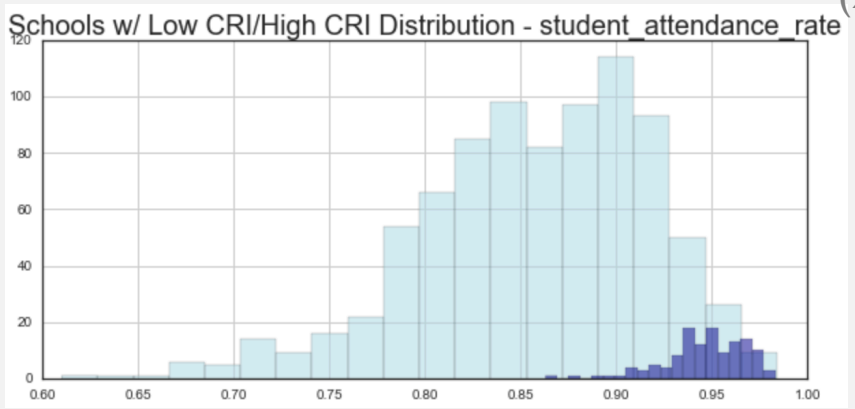

Median=Dataset: 4.5 | Low CRI: 4.5 | High CRI: 6



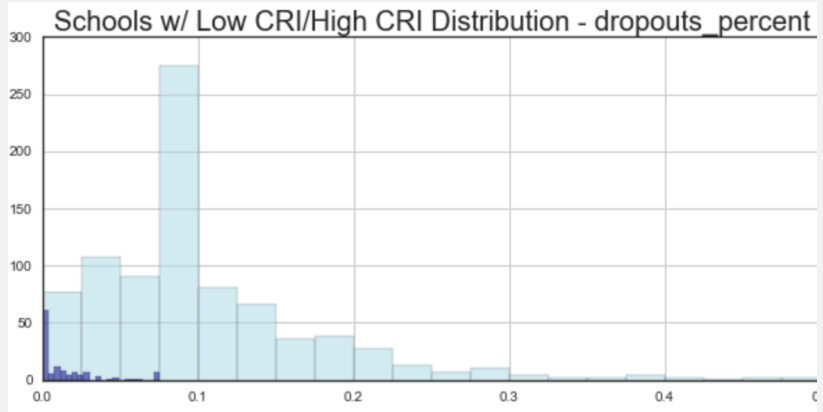

Median=Dataset: 46% | Low CRI: 51% | High CRI: 22%




Median=Dataset: 50% | Low CRI: 52% | High CRI: 37%
(25%=Most Diversity | 100% = Least Diversity)




Median=Dataset: 88% | Low CRI: 87% | High CRI: 95%

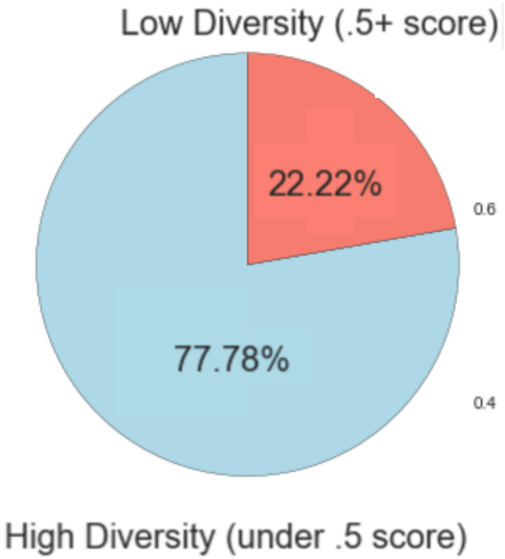


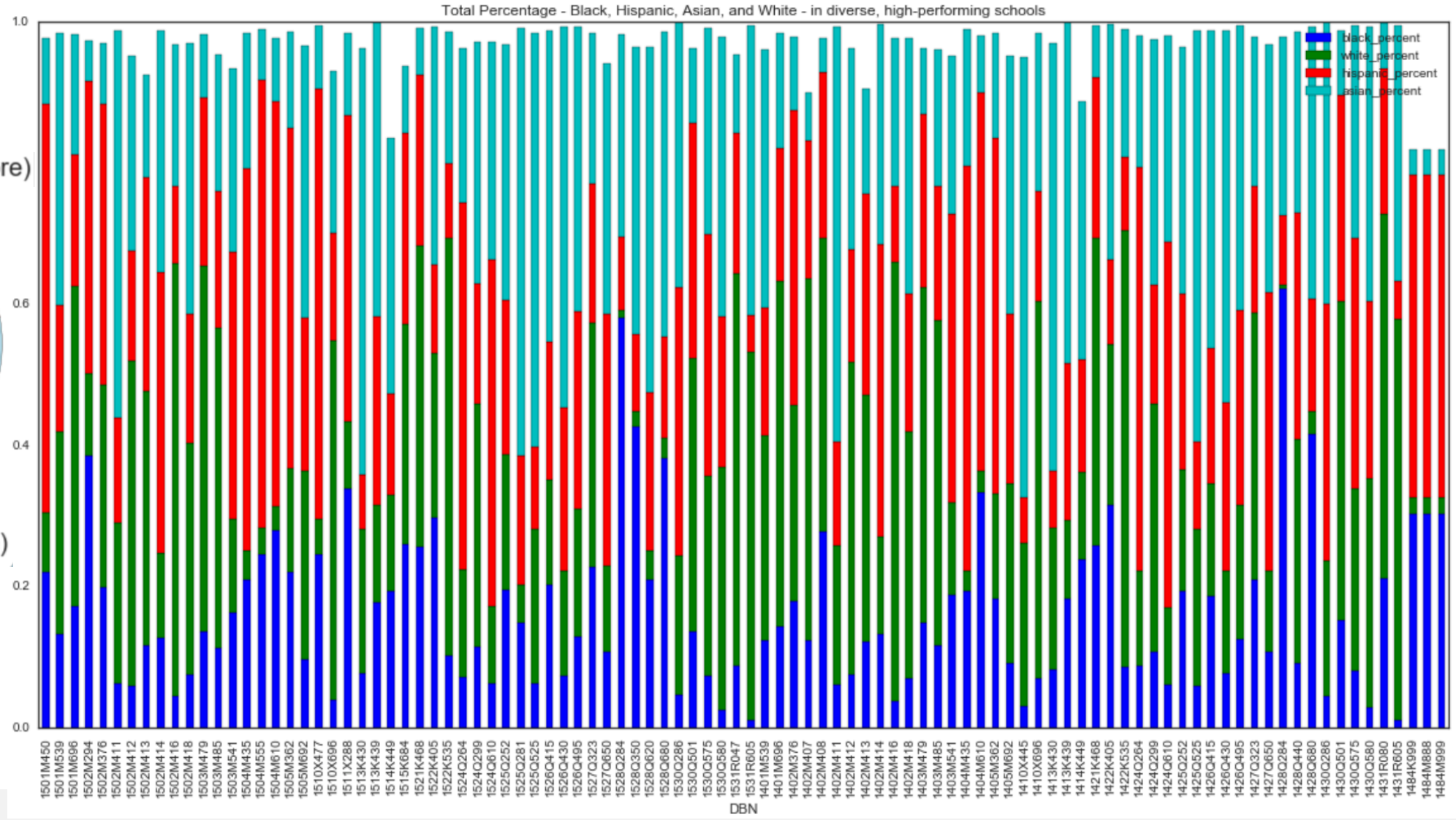

Median=Dataset: 8% | Low CRI: 8% | High CRI: 0.4%

Key: = Schools with Low CRI
= Schools with High CRI

# OBSERVATIONS (CONT'D)

Population Diversity in High-Performing Schools



# MODELING

- **Minimum Benchmark using Dummy Classifier:**

| Precision | Recall | F1-Score |
|---|---|---|
| .79 | .81 | **.80** |

- Random Forest
  - Protect against overfitting (great because I have a considerable amount of features)
  - Will tell me most important features (which I can feed into other models)
- Logistic Regression
  - Lasso/ridge will drop/let me know unimportant features
  - Will allow me to view feature coefficients
- k-means Clustering:
  - I may be able to discover distinguishable groups of schools to find some counterintuitive combinations of characteristics as well as obvious ones

```
list(data_rses)
```

```
['female_percent',
 'male_percent',
 'poverty_percent',
 'avg_home_value_sqft',
 'asian_percent',
 'black_percent',
 'ell_percent',
 'hispanic_percent',
 'self-contained_percent',
 'disability_percent',
 'white_percent',
 'population_diversity',
 'label']
```

# MODELING – RANDOM FOREST

- RESULTS:

| | Precision | Recall | Dummy Classifier F1-Score | **F1-Score** | **% Change** | **Time** |
|---|---|---|---|---|---|---|
| data_noexam | .86 | .86 | **.80** | **.86** | **+7.5%** | 3.99 ms per loop |
| data_admin | .86 | .86 | **.80** | **.86** | **+7.5%** | 4.42 ms per loop |
| data_zip | .82 | .86 | **.80** | **.84** | **+5%** | 17.3 ms per loop |
| data_rses | .64 | .82 | **.80** | **.72** | **-10%** | 2.87 ms per loop |

- Three out of the four datasets beat the dummy classifier
- data_rses (with student demographics/characteristics) is worst-performing
- data_noexam (which has no geographic info) is marginally best-performing

| Features | Importance Score |
|---|---|
| grade8_proficiency | 0.149885 |
| grade8_math | 0.125332 |
| grade8_english | 0.124609 |
| sat_percent_took_exam | 0.071781 |
| student_attendance_rate | 0.068905 |
| dropouts_percent | 0.061824 |

| Features | Importance Score |
|---|---|
| ell_percent | 0.193844 |
| asian_percent | 0.150225 |
| disability_percent | 0.142821 |
| poverty_percent | 0.115429 |
| white_percent | 0.071317 |
| black_percent | 0.063662 |

# MODELING – LOGISTIC REGRESSION

- RESULTS:

| | Precision | Recall | Dummy Classifier F1-Score | **F1-Score** | % Change | **Time** |
|---|---|---|---|---|---|---|
| data_noexam | .82 | .86 | **.80** | **.84** | **+5%** | 47.7 Microsecs per loop |
| data_admin | - | - | - | - | - | - |
| data_zip | - | - | - | - | - | - |
| data_rses | .60 | .76 | **.80** | **.67** | **-16%** | 44.8 Microsecs per loop |

- Logistic Regression was not as successful as Random Forest
- Large amount of features in data_admin and data_zip made LR prohibitive

| coefficients | features |
|---|---|
| 1.537 | student_attendance_rate |
| 1.322 | grade8_math |
| 0.997 | grade8_proficiency |
| 0.927 | violation_offenses |
| 0.917 | ell_percent |
| 0.914 | sat_percent_took_exam |
| 0.685 | school_day_length |
| 0.590 | poverty_percent |

| | |
|---|---|
| -1.351 | population_diversity |
| -1.356 | self-contained_percent |
| -1.779 | white_percent |
| -1.996 | asian_percent |
| -3.197 | black_percent |
| -3.255 | hispanic_percent |
| -3.774 | dropouts_percent |

| | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| female_percent | 0.472 | 0.435 | 0.531 | 0.532 |
| male_percent | 0.528 | 0.565 | 0.469 | 0.468 |
| poverty_percent | 0.946 | 0.867 | 0.822 | 0.531 |
| avg_home_value_sqft | 420.117 | 385.978 | 515.952 | 583.631 |
| grade8_english | 1.845 | 2.219 | 2.469 | 3.128 |
| grade8_math | 2.112 | 2.100 | 2.375 | 3.054 |
| enrollment | 385.818 | 481.699 | 599.564 | 1473.037 |
| asian_percent | 0.171 | 0.033 | 0.079 | 0.282 |
| black_percent | 0.083 | 0.477 | 0.396 | 0.127 |
| ell_percent | 0.819 | 0.117 | 0.070 | 0.031 |
| hispanic_percent | 0.687 | 0.451 | 0.450 | 0.234 |
| self-contained_percent | 0.009 | 0.094 | 0.034 | 0.020 |
| disability_percent | 0.039 | 0.252 | 0.174 | 0.109 |
| white_percent | 0.053 | 0.027 | 0.053 | 0.329 |
| cte_percent | 0.032 | 0.021 | 0.034 | 0.026 |
| arts_percent | 0.021 | 0.008 | 0.031 | 0.050 |
| act_percent_took_exam | 0.064 | 0.038 | 0.088 | 0.227 |
| sat_percent_took_exam | 0.569 | 0.481 | 0.704 | 0.828 |
| student_attendance_rate | 0.885 | 0.818 | 0.895 | 0.938 |
| school_environment_survey | 0.885 | 0.812 | 0.852 | 0.876 |
| teacher_attendance | 0.972 | 0.961 | 0.968 | 0.968 |
| principal_year_exp | 4.727 | 4.461 | 5.062 | 5.355 |
| dropouts_percent | 0.102 | 0.142 | 0.062 | 0.022 |
| major_crimes | 1772.795 | 1713.769 | 1482.761 | 1333.402 |
| violation_offenses | 947.909 | 1008.803 | 851.812 | 743.729 |
| school_day_length | 428.727 | 424.368 | 421.139 | 412.243 |
| population_diversity | 0.639 | 0.565 | 0.514 | 0.369 |
| grade8_proficiency | 3.957 | 4.320 | 4.844 | 6.182 |
| all_crime | 2720.705 | 2722.572 | 2334.573 | 2077.131 |

# MODELING – K-MEANS

- **Cluster 0 – A Challenging Start**
  - Low Grade 8 Proficiency Scores
  - High Hispanic Percentage and ELL rates
  - High population diversity index, suggesting low diversity
  - High Poverty percentage
  - High crime areas
  - Small schools
- **Cluster 1 – Difficulty Staying On Track**
  - Large disability percentage rates
  - Low attendance and test-taking rates
  - High drop-out rates and percentage of black students
- **Cluster 2 – On the Right Track**
  - Despite poverty figure, schools appear to be in wealthy neighborhoods
  - Slightly above average testing scores
  - Slightly above avg diversity index, suggesting slightly low diversity
  - Presents similarly like cluster1 for race/ethnicity but with slightly smaller numbers, but has better testing, attendance, and dropouts
- **Cluster 3 – Large and High-Achieving**
  - Large Asian population (Mean of entire dataset: 9%), so overrepresentation in this cluster → same with white percent
  - Low population diversity index, suggesting high diversity
  - High Grade 8 Proficiency scores

# CHALLENGES/SUCCESSES

- CHALLENGES:
  - Putting together so many different datasets was time-consuming
  - Realized late in the process that I had forward-looking features that previously were artificially boosting my score
    - Removing them significantly decreased model performance
    - Wasted time running models I couldn't use (including SVM, which would not run on new models)
  - Datasets I tested with geographic dummy categoricals had so many features that Logistic Regression wouldn't run

- SUCCESSES:
  - Interesting exploration and important features for insights
  - Some models beat benchmark, which means we can successfully answer project question

# CONCLUSIONS

- INSIGHTS:
  - While students who belong to historically marginalized groups also appear less frequently in schools with high college readiness rates, their presence alone is not an accurate predictor of whether a school has a high or low rate of college readiness.
  - Although schools with high college-readiness rates appear to have higher amounts of diversity (or dispersion) than schools with low rates of college readiness, this feature did not score highly on RF's Feature Importance nor as a coefficient for LR.
  - Grade 8 Proficiency seems to be one of strongest predictive factors for college readiness
- FUTURE STEPS:
  - Complete similar work but on middle/elementary schools
    - What contributes to those Grade 8 Proficiency scores?
  - Clustering with geographic data
    - More exploration
  - Compare data over several years as more is released