

Optimal Funding Patterns for Educational Institutions

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Problem Statement

Current Scenario:

- Many deserving institutions/states are in requirement of funding to enhance quality education

Goal: Maximize student learning while minimizing money spent.

Why:

- Identify a correlation between funding and academic success
- Gaining insights on the distribution of funds across institutions and various demographics

Prior Work

- Effects of increased school funding:
 - Increased average test scores¹
 - Increased graduation rates²
 - Increased adulthood income^{1,3}
 - Decreased adulthood poverty³
- Benefits from increased textbook spending⁴
- Mixed results from capital & construction spending⁵

What's missing?

Not much research on which *types* of spending are most impactful.

Research Questions

RQ1: What trends can we infer in school funding patterns using visualizations?

RQ2: What factors contribute the most to a students grade?

Dataset

- Using the “U.S. Education Datasets: Unification Project” dataset on Kaggle.
- State-wise data for distribution of funding across different categories.
- NAEP Yearwise Scores by Gender, Race/Ethnicity for *Mathematics* and *Reading*
- US Census Finance Data

Methodology Overview

1. Data Preparation:

- a. Trim dataset of invalid/useless data
- b. Adjusting for Time Value of Money

2. Perform Exploratory Data Analysis

3. Models to predict Grades based on attributes.

4. Find per-model feature importance from all 266 attributes

Categorizing the states

| | | | | | |
|---------------------|----------------|-----------------|-------------|-------------------|--------------------|
| <u>TOP 5</u> | Georgia | Kentucky | Utah | New Mexico | Mississippi |
|---------------------|----------------|-----------------|-------------|-------------------|--------------------|

| | | | | | |
|------------------------|-----------------|---------------------|------------------|---------------------------------|---------------------------|
| <u>BOTTOM 5</u> | Delaware | Pennsylvania | Louisiana | District Of Columbia | South Carolina |
|------------------------|-----------------|---------------------|------------------|---------------------------------|---------------------------|

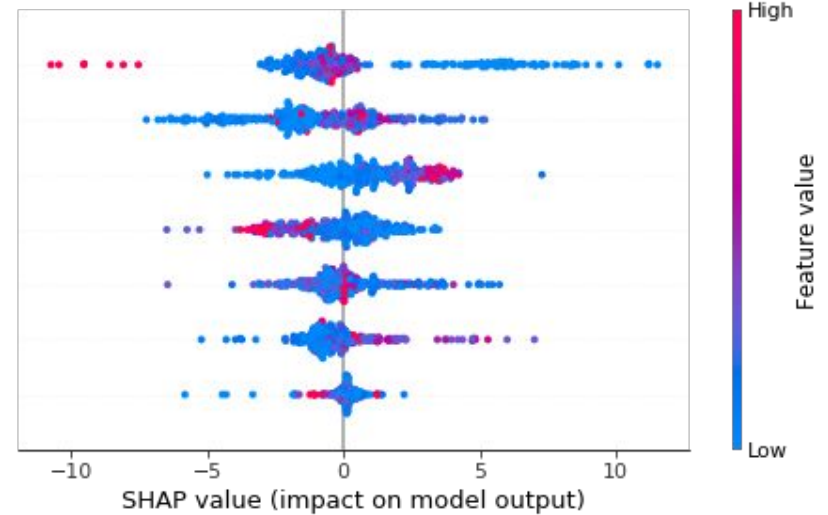
Methodology: Modeling

- Finding Collinearity between attributes.
- **Models:**
 - Decision Tree
 - Linear Regression
 - Support Vector Regression
- Identifying Feature Importance (SHAP values)

Results: Decision Tree

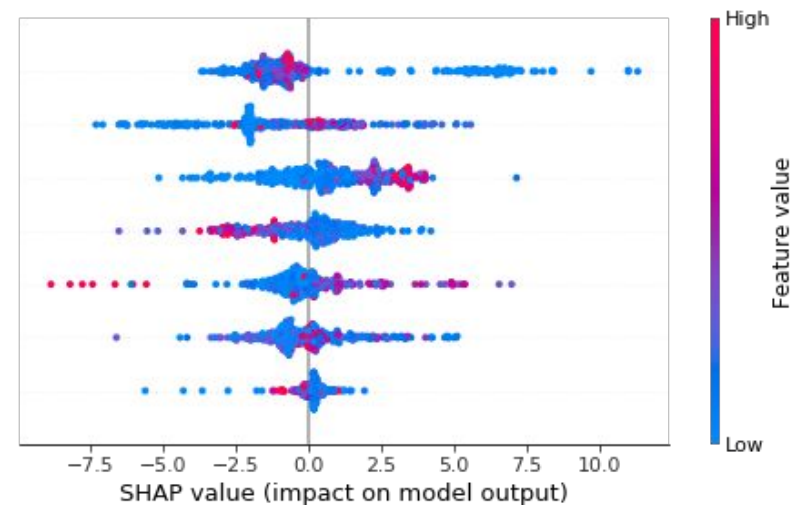
Top 5

STATE_REVENUE
INSTRUCTION_EXPENDITURE
LOCAL_REVENUE
FEDERAL_REVENUE
OTHER_EXPENDITURE
SUPPORT_SERVICES_EXPENDITURE
CAPITAL_OUTLAY_EXPENDITURE



Bottom 5

STATE_REVENUE
INSTRUCTION_EXPENDITURE
LOCAL_REVENUE
FEDERAL_REVENUE
SUPPORT_SERVICES_EXPENDITURE
OTHER_EXPENDITURE
CAPITAL_OUTLAY_EXPENDITURE

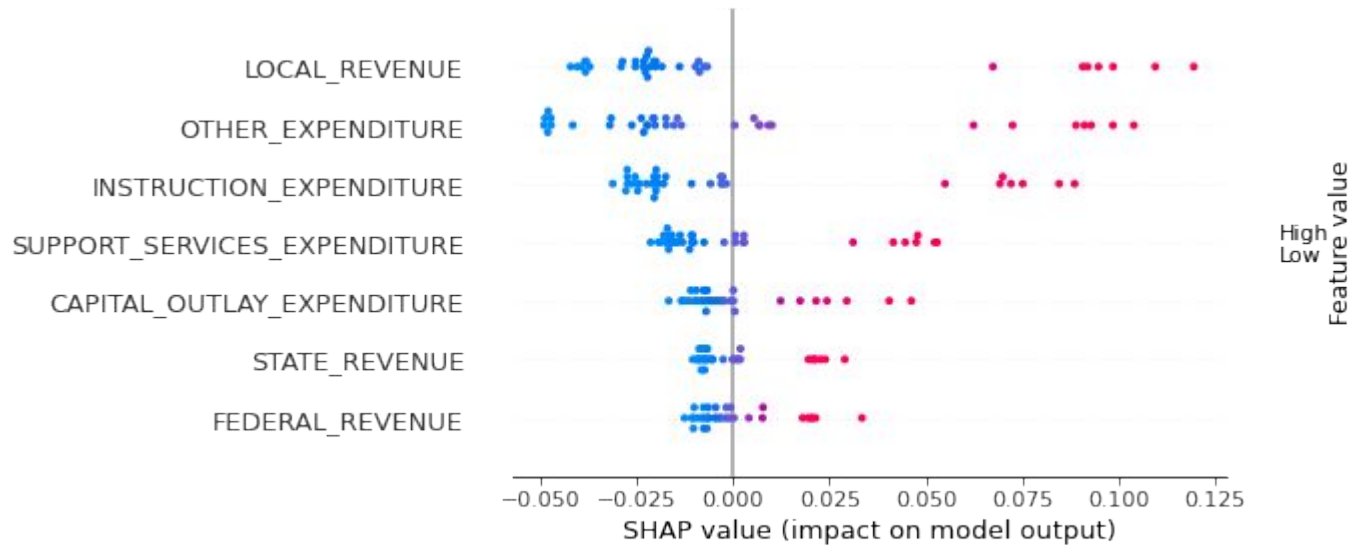


Results: Linear Regression

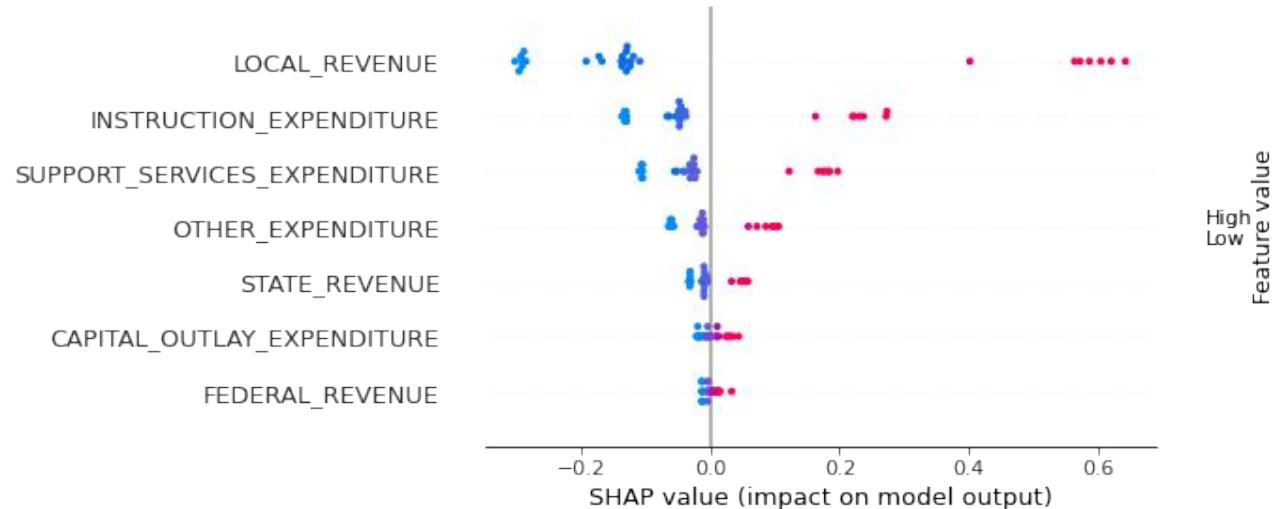
| Feature | Correlation | |
|------------------------------|-------------|----------|
| | TOP 5 | BOTTOM 5 |
| LOCAL_REVENUE | Positive | Positive |
| SUPPORT_SERVICES_EXPENDITURE | Negative | Positive |
| INSTRUCTION_EXPENDITURE | Negative | Negative |
| STATE_REVENUE | Positive | Positive |
| OTHER_EXPENDITURE | Positive | Negative |
| FEDERAL_REVENUE | Positive | Positive |
| CAPITAL_OUTLAY_EXPENDITURE | Positive | Positive |

Results: Support Vector Regression

Top 5



Bottom 5



Conclusions

- **Instruction Expenditure** has a high, negative impact on average grades.
 - Potentially because the bottom 5 states have an average of ~\$5,000 higher teacher salary, meaning more has to be spent on this instead of other areas.
- All **Revenue** streams have a positive impact on a students grade.
- **Support Services** show higher benefits in low-performing states.

Issues Encountered

- Accounting for inflation in historical data
- Fairly high-level and limited data (only ~1700 rows)
- Vague attributes allow for a lot of unexplainable findings
- Making visuals that can be compared among the models

Future Work/Extensions

- Investigate a common occurrence of having leftover funding (Revenue > Expenditure).
- Leverage the analysis for predicting future revenue costs needed to improve grades.
- Understand why the models were showing such stark differences in SHAP values.

References

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2. C. A. Candelaria and K. A. Shores. Court-Ordered Finance Reforms in the Adequacy Era: Heterogeneous Causal Effects and Sensitivity. Education Finance and Policy, 14(1):31–60, 01 2019.
3. C. K. Jackson, R. C. Johnson, and C. Persico. The effects of school spending on educational and economic outcomes: Evidence from school finance reforms. Working Paper 20847, National Bureau of Economic Research, January 2015.
4. K. L. Holden. Buy the book? evidence on the effect of textbook funding on school-level achievement. American Economic Journal: Applied Economics, 8(4):100–127, October 2016.
5. C. K. Jackson. Does school spending matter? the new literature on an old question. American Psychological Association, December 2018.

Questions?