Optimizing High School Graduation Rates

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The View From 30k Feet

- Deliverable: A customizable model which produces a strategy to optimize graduation rates for a particular school/district.
- We're presenting the model as a tool. Flexibility and user customization is as big a part of this deliverable as the optimal result.
- The solution generated by this model is NOT designed to be the de-facto solution to the problem of low graduation rates. Rather, this model should be paired alongside a wholistic approach by the administration. People are not machines.

Regression And Optimization

We're using a regression line-of-best-fit to motivate our objective function.
The regression will produce a linear function of form

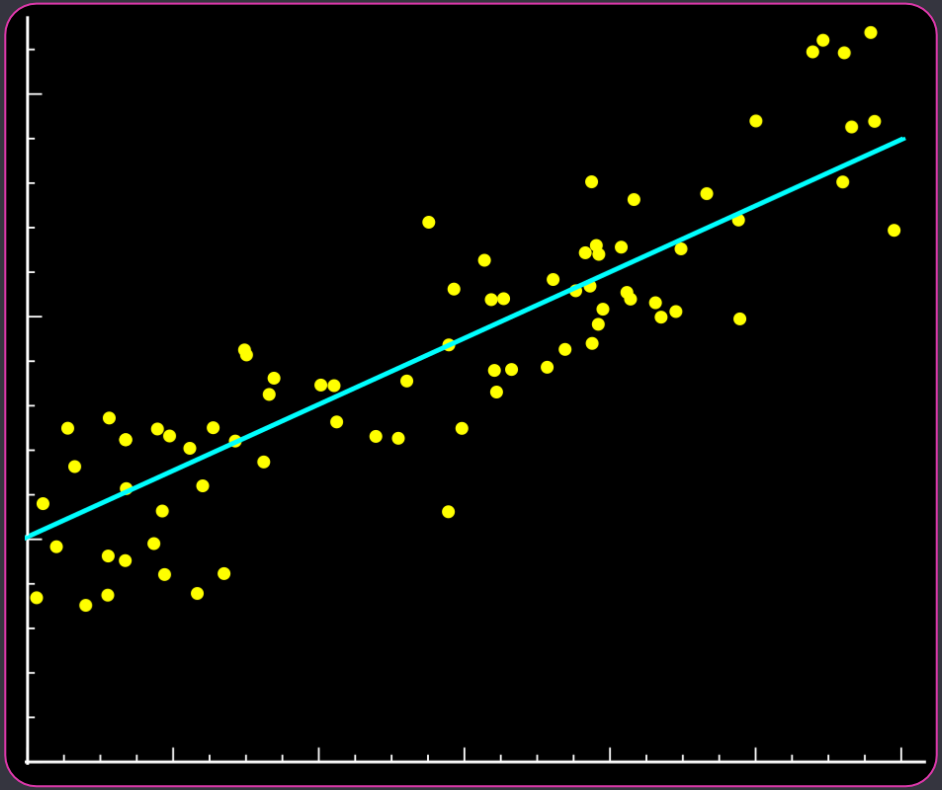
$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ \dots + \beta_m x_m$$

We'll rearrange the coefficients and variable

$$C = \begin{matrix} \beta_1 \\ \beta_2 \\ \dots \\ \beta_m \end{matrix} \qquad X = \begin{matrix} x_1 \\ x_2 \\ \dots \\ x_m \end{matrix}$$

and formulate the objective function to the linear program

$$\min C^T X$$



Linear Regression Model For Objective Function

- The objective function comes from the regression equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ \dots + \beta_m x_m$$

  where y is the graduation rate, $x_i's$ are the variables used in the model, and the coefficients $\beta_i's$ represent the contribution of each variable to the graduation rate based on a linear regression model.

- We use a Least Absolution Deviation (LAD) Regression in order to generate this model.
  - This form of regression is robust to outliers in data.

Construction Of The Objective Function

- The full regression equation from the data has the form:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_m x_m$$

- Constructing this equation we define the following:
  y_i is the graduation rates for each district considered in the analysis
  x_{ij} is the observed variables, j, for the i^{th} district with $x_{i0} = 1$,and
  β_j is the variable representing the coefficient for the j^{th} variable

- i ranges from 1 to n, where n is the number of districts in our sample
  j ranges from 0 to m, where m is the number of variables considered in the model

Construction Of The Objective Function

- The LP then to generate this regression equation has the form:

$$\min \sum_{i=1}^{n} t_i$$

$$s.t.$$

$$-t_i \leq y_i - \sum_{j=0}^{m} \beta_j x_{ij} \leq t_i \,, i = 1, \ldots, n$$

Chosen Variables For Our Model

- Student teacher ratio
- Average teacher Salary
- Median house cost
- Faculty turnover rate
- Number of students in advanced classes
- Demographic disparity between teachers and students
- Male vs female teacher ratio
- Number of students in special education

Chosen Constraints For The Model

- Budget, will be affected by:
  - Student teacher ratio, Teacher salary, Faculty turnover rate
- Size of school, will be affected by :
  - Student teacher ratio, number of students in advanced classes, number of students is special education
- Restrictions on:
  - Median home cost, Faculty turnover rate, number of students in advanced classes, Demographic disparity between teachers and students, Male vs Female teacher ration, number of students is special education

Limitations And Potential Extensions

- Use for several different states
  - Compare different objective functions and different solutions for different states
- Add more variables
  - Teacher experience, after school programs, parent education level, etc
- Account for the interrelation of certain variables

References And Resources

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Any Questions?