

Math 480 - Course Project

Modeling and Optimizing Computer Science & Engineering Admissions

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1 Team

The project is comprised of students from Prof. Billey's Math 480 Spring Quarter 2016 class. The members of this team are:

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2 Project Title

Modeling and Optimizing Computer Science & Engineering Admissions

3 Description

The University of Washington's Computer Science & Engineering (CSE) Department undergraduate program is competitive. Admission to the program is determined by committee after prerequisite classes are taken. The CSE department has information regarding past applicants. This information includes:

- University of Washington GPA
- Highest grades from each prerequisite class:
 - CS 142

- CS 143
- MATH 124
- MATH 125
- MATH 126
- Approved Science Course
- English Composition Course
- Number of repeated prerequisite classes
- SAT scores
- Presence of survey from CS 142-143 Series
- Admission to CSE program

We are tasked with creating a predictive model to match the decision of the admissions committee given select information from applicants. Once the predictive model has been formulated, we will examine techniques that could be used to organize applicants and optimize decisions by the committee.

4 Impact

The University of Washington’s CSE program is ranked in the top ten in the nation.¹ Currently there are roughly 750 undergraduate students² undergraduate students in the CSE program and less than 30% are admitted to the program³. The prestigious standing of the program with the large number of applicants warrants examination of this process.

The process of admissions is not unique to the CSE program nor University of Washington. Solutions and methods to optimize this process should be universal and could be applied to general admissions to universities, graduate programs, or other competitive programs.

Our team has contacted Principal Lecturer of CSE, Stuart Reges, who is advising the project and relaying information from the admission committee. We have also consulted with Prof. Billey. She is a member of the Steering Committee of ACMS, which is responsible for admissions.

5 Methods

We plan to use a multipart approach for modeling and optimizing admissions.

¹https://www.cs.washington.edu/prospective_students/undergrad

²https://www.cs.washington.edu/about_us

³https://www.cs.washington.edu/prospective_students/undergrad/admissions

Model

The first step would be creating a predictive model. This step still utilizes optimization, but will result in a function for predictive modeling. The predictive model would be a linear programming problem which minimizes the deviation of the predictive model's decision of admission from actual admission. This would provide different weights for each category provided. This could then be used to determine the importance of each category, and would allow for experimentation to see the results of aggregating certain categories and ignoring certain categories.

Optimization of admission process

This step would involve different approaches to organize students in order to make the decision by the committee more efficient. This could be approached as a chunking problem, where students are arranged into chunks of like students. The student with the median deviation from other students, could then be used as a representative for that group. Then each group could be treated with special conditions and rules.

Another approach could be translating the problem into a travelling salesman problem (TSP). Each student represents a node, with weighted edges determined by the deviation from dominant factor of the model process (e.g. UW GPA).

6 Example

This example demonstrates how the modeling process determines the weight of each category. This is presented as a mixed integer programming problem and is a rough draft.

Variables

Let:

$y_i = 1$ if student predicted to be admitted, 0 otherwise

$z_i =$ deviation from actual acceptance

$x_1 =$ weight of UW GPA

$x_2 =$ weight of CS 142 GPA

$x_3 =$ weight of CS 143 GPA

$x_4 =$ weight of MATH 124 GPA

$x_5 =$ weight of MATH 125 GPA

x_6 = weight of MATH 126 GPA

x_7 = weight of Science Course GPA

x_8 = weight of English Course GPA

x_9 = weight of SAT scores

x_{10} = weight of CSE survey presence

s_{ij} = student i's respective scores for $j = 1, 2, \dots, 10$

s_{11} = student's actual acceptance

Objective Function

$$\text{Min} \sum_{i=1}^n z_i$$

Constraints

Set the prediction of admission or not based on weights, C is an arbitrarily large constant

$$Cy_i \geq x_1s_1 + x_2s_2 + x_3s_3 + x_4s_4 + x_5s_5 + x_6s_6 + x_7s_7 + x_8s_8 + x_9s_9 + x_{10}s_{10} \quad \forall i$$

Set deviation if prediction is wrong

$$z_i \geq y_i - s_{i,11} \quad \forall i$$

7 References

The following study may prove useful in the results phase of the project. Certain scores may not be useful in predicting an applicant's potential.

Physics GRE Scores of Prize Postdoctoral Fellows in Astronomy
by Emily M. Levesque, Rachel Bezanson, & Grant R. Tremblay ⁴

⁴<http://arxiv.org/abs/1512.03709>