Correlation of Admission Data to Undergraduate Student Success in Electrical Engineering

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Abstract

In the Electrical Engineering (EE) program at the University of Washington (UW) Bothell, a weighted average score is used as admissions criterion for undergraduate electrical engineering students. The score comprises calculus, physics and chemistry grades, overall student GPA and a rating of the student's personal statement. This paper presents statistical data to show how well student success in electrical engineering is correlated with the admissions criteria. Results of regression analysis show that there is a positive correlation between sophomore-level electrical engineering course grades and the weighted average admission scores. The results also show that calculus grades are the strongest predictors, while the overall student GPAs are the weakest predictors, of electrical engineering courses GPA. The paper sheds light on the results of the study and makes recommendations for improved criterion for admissions in electrical engineering programs.

Introduction

Identification of applicants who will be successful students is important for saving the resources of a program and the students. The identification of such applicants requires devising effective admission criteria and process. Various criteria and methods are employed by different institutions across the country to admit students into their Electrical Engineering (EE) programs. Many institutions admit students to the EE programs directly from high school as freshmen students. Others admit students after completion of a set of prerequisite courses which primarily are calculus and physics courses or other pre-engineering courses. For students who are admitted at the freshman level, SAT scores and high School GPA are, in most cases, assigned the highest priority in making admission decisions. On the other hand, EE programs that admit students after completion of specific prerequisite courses or pre-engineering courses, base admission decisions on grades earned during the college years of students.

In this paper, we explore the admission criteria for programs that admit students at sophomore or junior level after completion of certain prerequisite courses. We specifically investigate whether grades of certain courses are better indicators of student success than students' cumulative GPAs. The study is done by performing correlation analysis of student performance to admission statistics. Such analysis is beneficial for improvement of the admissions process and the quality of students.

In the following sections, brief descriptions of the EE program at UW Bothell and its admissions criteria are provided. Correlational analyses results linking admission data to lower-level EE course grades are presented. Recommendations are made for improvement of the admissions process and expansion of the study in the future.

Electrical Engineering Program and Admission Criteria

The EE program at UW Bothell offers students BS (since 2010) and MS (since 2015) degrees. The educational experience of the EE program is based on strong student-faculty relationships, small classes and hands-on learning. The BSEE program, accredited by ABET, is designed to meet the needs of technology-oriented employers in the Puget Sound region. The program culminates in a capstone design course whereby student teams implement a design with a faculty advisor and a corporate sponsor.

Students are required to complete a specific set of prerequisite courses before admission to the EE program at UW Bothell. These prerequisite courses are Calculus I, Calculus II, Calculus III, Physics I, Physics II, Introduction to Chemistry and English. The admission criteria employs a point system with a total score of 1000 points assigned to prerequisite course grades, overall student GPA, and a student's personal statement. The admission criteria assigns significant weight to mathematics and physics grades, in contrast to overall GPA, since it is widely accepted that a strong background in basic sciences is a strong indicator of success in an engineering program. Therefore, while the overall GPA is assigned 150 points, accounting for 15% of the total score, the mathematics and physics courses are assigned a total of 650 points (65% of the total score) by allocating 150 points to each calculus course and 100 points to each physics course. The chemistry grade and personal statement are assigned 50 and 150 points respectively. Student personal statements are reviewed by three faculty and are subjectively assigned ratings. Table 1 lists the weights assigned to admission requirements. Applicants are ranked according to admission scores and an appropriate number of students are admitted in the EE program.

Table 1: Admission score weights

Subject	Score	Weight
Calculus GPA	450	45%
Physics GPA	200	20%
Chemistry GPA	50	5%
Overall GPA	150	15%
Personal statement	150	15%
Total	1000	100%

In sequel, we perform correlation analyses to investigate the effectiveness of these admission criteria, specifically in contrast to alternative admission criteria where the overall GPA is considered a significant indicator of student success.

Strength of Correlation

Pearson's correlation coefficient (r) is a measure of strength of a linear relationship between two variables. The following equation represents the mathematical formula used to compute r.

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \, (y - \bar{y})^2}}$$

Table 2 includes a verbal description of correlational strength used in this study.

Table 2: Correlational Strength

r	Strength of correlation
0 to 0.1	Very weak
0.1 to 0.3	Weak
0.3 to 0.5	Moderate
0.5 to 1	Strong

Descriptive Statistics

Figure 1 shows the histogram of EE average GPAs which comprises sophomore-level circuits and digital electronics course GPAs. The histogram includes GPAs of 51 students out of a total of 55 students enrolled at UW Bothell in Fall 2015. Four students had withdrawn from EE courses during the sophomore year. Four (or 8%) students had an EE average GPA of less than 2.0 . Twenty two (or 43%) students had an EE average GPA between 3.5 and 3.99 . The mean and median EE average GPAs were 3.19 and 3.5 respectively with a standard deviation of 0.77 .
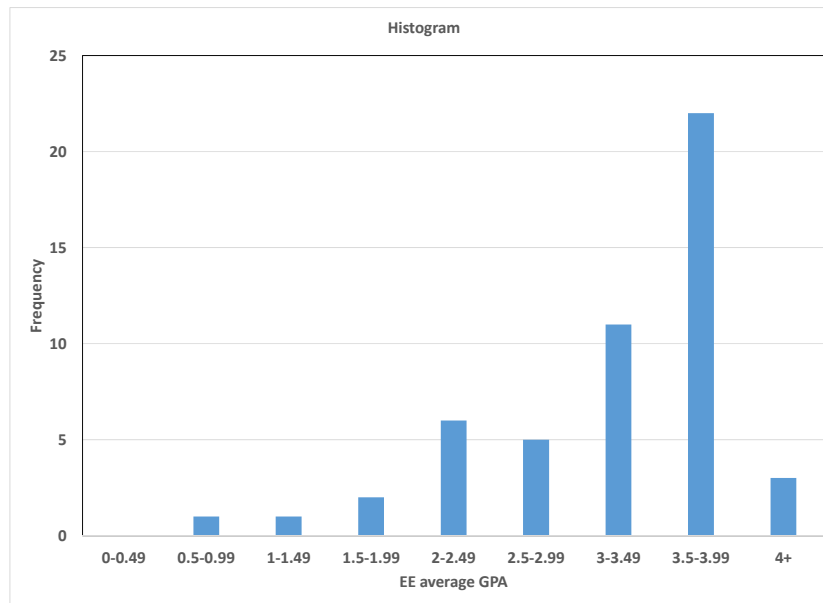

Figure 1: EE average GPA distribution

Correlation Results

A simple linear correlation analysis using Excel™ was conducted to determine the correlation between prerequisite course GPAs and EE sophomore-level GPAs. Figure 2 plots the EE sophomore-level average GPAs versus calculus average GPAs. The correlation coefficient of 0.45 indicates a moderate to strong correlation between these variables. Figure 3 plots the EE sophomore-level average GPAs versus physics average GPAs. The correlation coefficient of 0.22 indicates a weak correlation (unexpected) between these variables. Three outliers contribute to the weakness of the correlation.
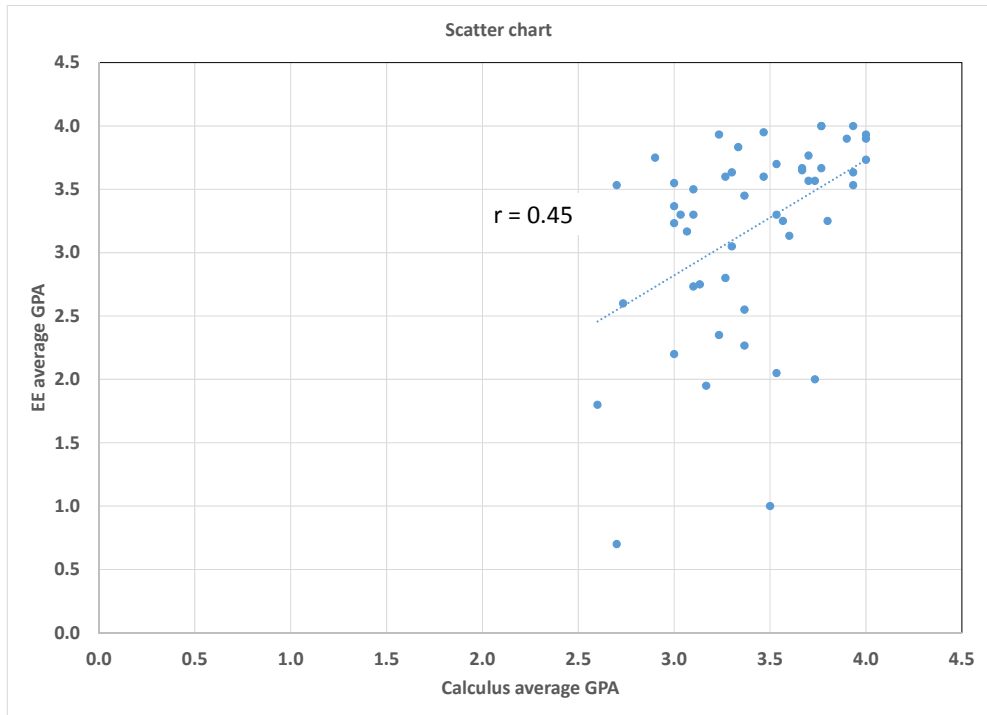
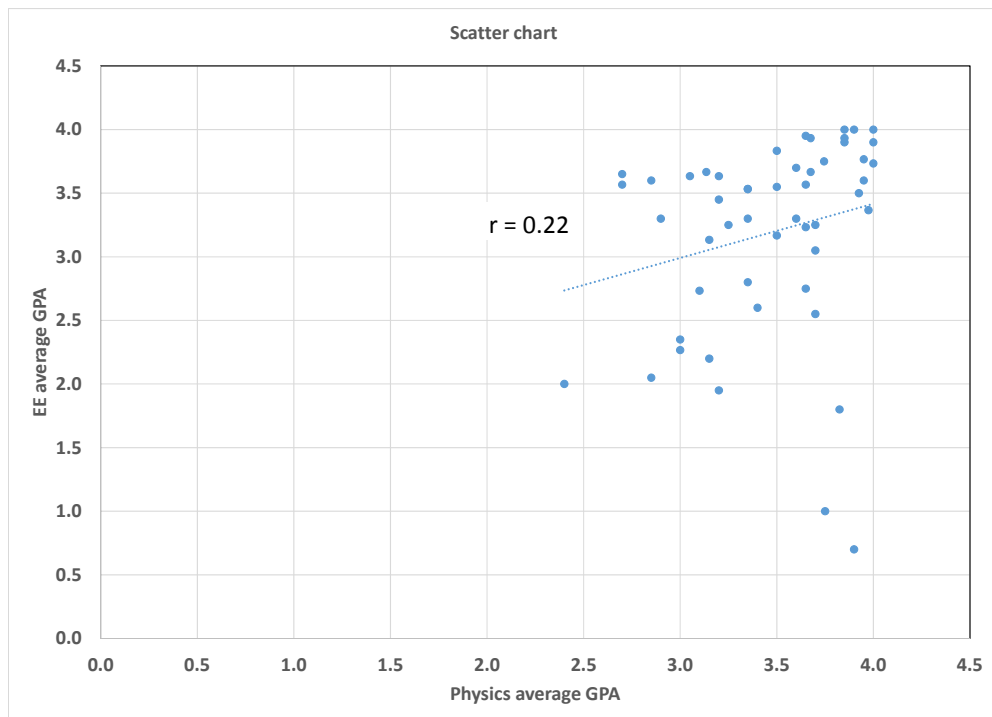Figure 2: EE average GPA versus calculus average GPA

Figure 3: EE average GPA versus physics GPA

Figures 4 and 5 show plots of EE average GPAs versus prerequisite (calculus, physics, chemistry) course GPAs and total scores used for admissions. The correlation coefficients of 0.53 and 0.5 respectively indicate strong correlations between these variables. This result is expected since the admission scores are heavily weighed by prerequisite course GPAs.
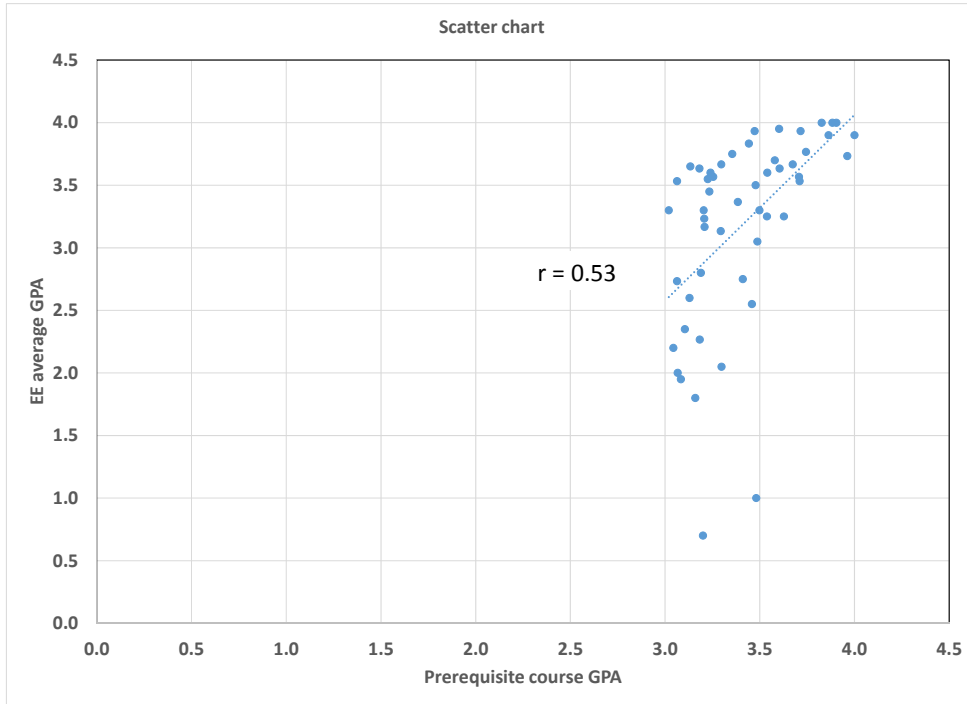

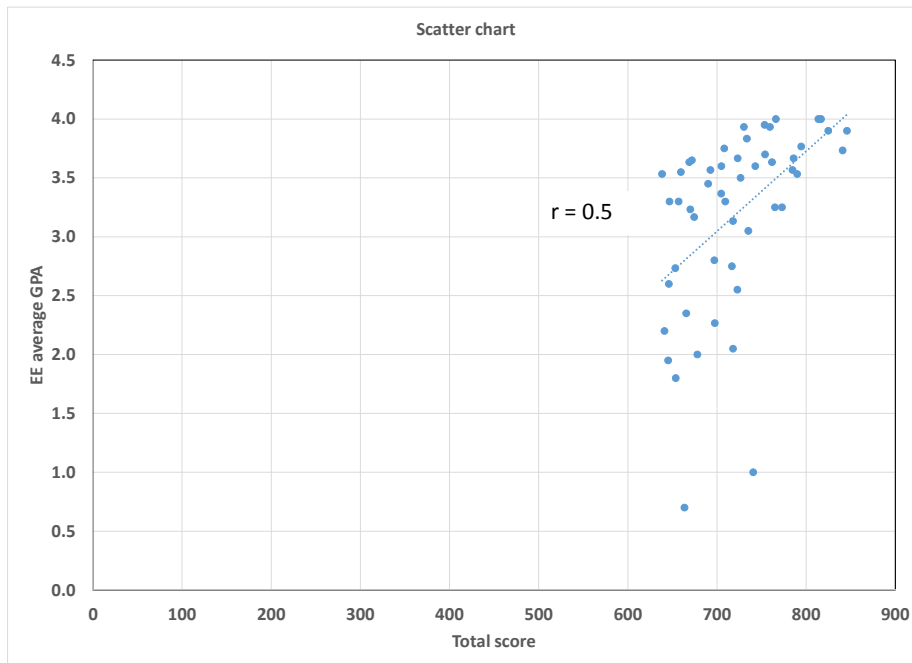Figure 4: EE average GPA versus prerequisite course GPA

Figure 5: EE average GPA versus total score used for admissions

Finally, the EE sophomore-level course average GPAs are plotted against student overall GPAs prior to admission to the EE program (Figure 6). The correlation coefficient of 0.13 indicates a very weak correlation between these variables. Table 2 summarizes the correlation analysis results of all the variables included in this study.
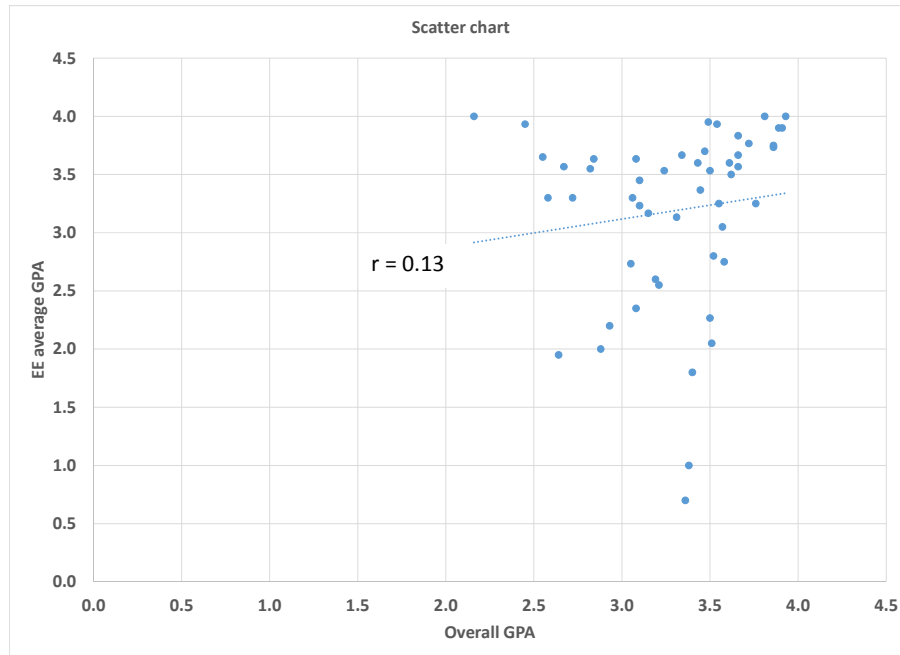

Figure 6: EE average GPA versus overall GPA prior to admission to EE program

Table 3: Correlation analysis results summary

Variable 1	Variable 2	r	Level of correlation
Calculus average GPA	EE Fundamentals	0.33	Moderate
Calculus average GPA	Circuit Theory	0.43	Moderate
Calculus average GPA	Digital Circuits	0.59	Moderate to strong
Calculus average GPA	**EE Avg.**	**0.45**	**Moderate**
Physics average GPA	EE Fundamentals	0.29	Weak to moderate
Physics average GPA	Circuit Theory	0.37	Moderate
Physics average GPA	Digital Circuits	0.015	Weak
Physics average GPA	**EE average GPA**	**0.22**	**Weak**
Chemistry average GPA	EE average GPA	0.39	Moderate
Prerequisite course GPA	**EE average GPA**	**0.53**	**Moderate to strong**
Overall GPA (prior to admission)	**EE average GPA**	**0.13**	**Very weak**
Total score (out of 850)	**EE average GPA**	**0.50**	**Moderate**

Implications and Conclusions

The results of this study suggest that student performance in prerequisite calculus courses are strong predictors of success in electrical engineering at UW Bothell. The study further suggests that performance in electrical engineering is not well correlated with overall student GPA. This statement may not be generalized to all other institutions. However, we think that this conclusion applies to institutions such as ours where the bulk of the student body is transferred from community colleges and comes from a diverse academic and socio-economic background.

The admission scores used in admissions decisions are predictors of success in the EE program. This is illustrated by the statistical correlation between admission scores and EE course averages. However, in light of the results of the study, it is recommended to decrease the weight assigned to overall student GPA and increase the weight assigned to calculus averages in admission scores. Furthermore, it is recommended to improve the faculty evaluations of students' personal statements by focusing on key features of these statements.

Further Work

This study was conducted using data from one academic year. It is recommended to collect more student data to confirm the validity of the results obtained thus far. It is also recommended to expand the scope of the study in the future by examining the performance of transfer students versus students who complete prerequisites at the university level.