A Study of the Admissions Criteria into the Sc.B. Engineering Program at an Ivy League School

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Abstract

Applicants to undergraduate programs at the Ivy league schools along with their parents find, from time to time, the admission process as secretive, unpredictable, confusing, and arbitrary. In general, applicants submit scores of standardized test results, write essays, fill out lengthy application forms, including information on parental background, parental marital status, and siblings, turn in their high school GPA, class ranking, and teacher recommendations. These, referred to as applicant profiles, are carefully examined and analyzed by a team of admissions officers and they arrive at their decisions, utilizing a host of criteria. However, at the end, for those who are denied admission, the reasons for denial or the lack thereof leave them utterly confused and frustrated. Moreover, rumors such as Ivy league schools such as Brown University routinely denies admission to half of the valedictorians who apply, irrespective of whether such rumors represent statistical truths, only contribute to the confusion. Furthermore, the literature on the details of the admissions process is sparse and there appears to be little consensus relative to the criteria utilized by the admissions officers.

This paper presents a model of the admission process in terms of the applications that encapsulate the characteristics of the applicants and the admissions officers who represent the educational philosophy of the university or college. It describes a correlation-based, scientific study to evaluate the proposed model, wherein the parameter design reflects the knowledge and experience acquired during the second author's tenure as an advisor to the undergraduate admissions office for the Sc.B. engineering program at Brown University between 1989 and 1992. During this period, the second author examined over 900 randomly-selected applicants from diverse cultural and socio economic backgrounds and geographical regions in the US and international applicants and his assessments were treated as ``first reads," or key evaluations. The paper develops key non-financial aid related criteria -- academic and non-academic, based on those actually used in the selection of applicants into the Sc.B. (Bachelor of Science) program in engineering at Brown University. It models the biases of the admissions officers that stem from their beliefs of student profiles that would best succeed in the engineering environment at Brown, and proposes representative admission officers for this study. The paper then synthesizes hypothetical applicants with stochastic, i.e. random, yet representative profiles, develops a computer model of the proposed admission process that encapsulates the interaction between the beliefs of the admission officers and the applicant profiles, and simulates the admissions process for 10,000 engineering applicants. The admission decision results -- positive or negative, are then correlated with the respective applicant profile. Analysis of the correlations reveal that (1) admission officer biases play a strong role in determining the admission decision outcomes, (2) applicants with strong math ability, indicated through high math achievement test score, high physics achievement test score, strong parental educational background, high grade point average, and outstanding teacher recommendations, are favored by the representative type of admissions officers who evaluate Sc.B.

engineering applicants to Brown University, (3) reliance on a single criteria relative to the admission decision may be unwise, (4) universities and colleges are justified in requiring comprehensive information on the applicants, and (5) SAT scores, alone, play a surprisingly minor role in the admission decision. The findings corroborate well with actual experiences of the second author. It is pointed out that a principal aim of this paper is to help foster a logical and comprehensive understanding of the admissions process among future engineering applicants and their parents. Also, the results of the paper suggests that the admission officers may carefully record their belief structures, normalize the field values of the applications, and generate and analyze the processed scores, to generate early initial evaluations with reasonable confidence and to assist in the admission process.

1. Introduction

McDonough [1] observes that, among primarily upper-middle-class high school students and parents who view college as a pivotal career investment, the process of choosing colleges and preparing for admission has become extremely important. Parents are aware that going to a selective college increases one's social standing, contacts, and income potential. Today, the admissions process is often viewed as an erratic, highly competitive, chancey game over which neither parents nor students have much control. Kravets [2] paints a vivid picture of the typical applicant's frustration and apprehension.

Karen [3] describes the roles of academic achievement and ``ascription'' in the admission process at Harvard University, as examined in 1994. Karen notes that students whose parents have attended graduate or professional schools are over-represented among the Harvard applicant pool. Although Harvard requires the usual test scores, GPA, class rank, etc., and while an applicant with a stellar academic background has a high chance of being admitted, having family connection to Harvard, being black or American Indian, elite prep school attendance, being an athlete, and hailing from the local area, significantly affect one's probability of admission. Karen's analysis reveals huge differences in the achievement test averages among admitted applicants -- those with family connections, athletes, or attending elite prep schools, rank significantly lower academically than others.

The process of admission to engineering programs at universities and colleges including Ivy league schools such as Brown, is elaborate and comprehensive. Applicants, typically high school students in their senior year, are required to submit a comprehensive package that may include their (a) transcripts from grades 9 through 12, (b) recommendations from three or four teachers, one or two preferably from the areas of mathematics, physics, and chemistry, (c) SAT verbal and math sub-scores, (d) Achievement Test (ACH) scores in math-II, physics, chemistry, history, English, etc., (e) AP test scores in chemistry, computer science, etc., (f) evaluation from the school's guidance counselor with a statement relative to class ranking, (g) a school profile listing the percentage of the graduates going into four-year degree programs, (h) a hand-written essay describing an important experience in the applicant's life, (i) an essay describing the applicant's special aptitude and reasons for pursuing engineering, (j) a duly filled standard application, (k) rank-ordered list of program/degree choices of the applicant, (l) parental educational and employment background and marital status, (m) background on siblings' education, and (n) interview with an appropriate person related to the university. A number of other factors are utilized in the admissions process but are not considered in this study. These include the parents' ability to pay all or part of the tuition, citizenship or immigration status, payment of application fee or waiver, the state of origin of the applicant [4], and the psycho-educational characteristics [5] of the recovering student, where appropriate. Applications are accepted either in November, under the early action program, or in January as regular submissions.

Once an application folder is complete, it is assigned for review by the admissions officers, with the goal that every applicant is reviewed by at least three officers. The guidelines for the reviews differ greatly, ranging from a orally transmitted set of rules that constitutes the school's tradition to the complete discretion of the admissions officer. Given that there is appreciable turnover among admissions officers, this may result in wide variations of assessments. While one officer may deem an applicant a straight accept, another officer may completely reject the application. The expectation is that with three semi-independent reviews for each application, a consensus is likely.

Barbeau [6] describes the admissions problem faced by the typical university in the Province of Ontario, in Canada in the 1980s. Following the dissolution of the rigorous, universal system of high school graduation examinations and the widespread occurrence of non-uniform grade inflation among the high schools, the universities felt compelled to design a new admission process that would bring objectivity into ranking and weighting the relevant factors. They faced three choices which in turn had to be evaluated based on four criteria. The three choices were -- continue to accept grades assigned by the high schools but review individual students within 3\% of the cutoff for admission, calibrate the high school grades based on the past performance of students from the same school at the universities, or institute a common entrance examination for all students. The four criteria were -- fairness and equity for all students, predictability of future success at the university, economical to implement and administer the method, and acceptable to all parties. The universities resorted to the analytic hierarchy process (AHP), proposed by Saaty, to rank the options subject to the criteria. At the first level of the hierarchy, the four criteria are ranked with respect to the overall goal. At the second level of the hierarchy, each of the choices are assessed separately with respect to the criteria, leading to an overall ranking. While the analytic nature of AHP lends credibility to the process, the subjectivity lies in AHP's requirement that the user provide pair-wise comparisons of all options.

In analyzing the current admission process, Peacock [4] notes that it is more of an art than science. During the prolonged period of evaluation, biases and inconsistencies often develop in the admission officers, resulting from mood swings and changes in expectations and lead to unwise decisions. Often, the admissions officers develop a rating system which is determined not by a systematic process but the individual officer's desire to admit a student regardless of academic and personal strengths of the applicant. Peacock proposes a rating system that he believes would encourage consistency, objectivity, efficiency, and fair decisions.

With the exception of [6], none of the previous efforts reviewed in this paper engage in an objective and scientific evaluation of the role of the relevant factors in the admissions process. They focus primarily on surveys, frequently from admissions officers and teachers, and infrequently from parents and applicants. Furthermore, none of the efforts reviewed in this paper report any detailed study of the special requirements for the arts, sciences, or engineering disciplines. This paper focuses on the admission process for the engineering discipline, presents a correlation-based study to uncover the key criteria, and evaluates them in the light of the actual experiences of the second author at Brown University.

2. A Correlation-Based Approach to Evaluating Admissions Criteria

This paper proposes an underlying model of the admissions process and a statistical correlation based mechanism to examine the validity of the model. The key relevant factors, utilized to arrive at the admission decision, include the SAT Math score, SAT Verbal score, PSAT Math score, PSAT Verbal score, ACH Math I score, ACH Math II score, ACH Physics score, ACH Biology score, ACH Chemistry score, ACH English score, AP Math score, AP English score, AP Computer Science score, AP Biology score, AP Chemistry score, AP Physics score, Math recommendation letter, Humanities recommendation letter, grade point average (GPA), class rank, number of students matriculated from the school, college father attended, degree father earned, college mother attended, degree mother earned, college sibling attended, and degree sibling earned.

In the proposed model, every admissions officer's evaluation of an applicant reflects his/her own philosophy of education and his/her understanding of the college's underlying educational philosophy. The officer's philosophy manifests in a series of beliefs relative to each of the relevant factors which collectively determine his/her evaluation of the applicants. In this paper, for an officer, a number between 0 and 100 is assigned to each of the fields. A 0 for a given field implies that the officer places neither value nor relevance on this field relative to the admissions process. In contrast, a belief of 100 reflects that the officer places significant importance to this field. A belief of 50 implies average importance assigned by the officer to the field in question. An officer's evaluation of an applicant consists in multiplying the values in each of the fields of the application by his/her corresponding belief values and generating a cumulative sum, termed processed score. Once an officer has determined the processed scores for all of the applicants, he/she sets a

cutoff threshold, and arrives at the final admittance decision based on whether the applicant's processed score exceeds or falls short of the threshold.

While the absence of a consensus and an unambiguous set of criteria to test the accuracy of the decisions in the literature is noted, this paper proposes the following scheme to evaluate the proposed model. First, a set of 10,000 applicant profiles are synthesized wherein the value of each of the relevant factors is determined stochastically. This constitutes a representative and unbiased applicant pool which, presumably, includes all types of college applicants. Second, for each applicant, a raw score is computed as the cumulative sum of the values of all of the fields. Third, for each admissions officer, the raw scores of all 10,000 applicants are correlated against the corresponding processed scores, and the correlation coefficients and levels of significance, are computed. The correlation coefficient is a widely used statistical measure to investigate the relationship, dependence, or association between two variables. In an effort to bring objectivity into the admissions process, this paper examines the correlation coefficients for the large, representative, and unbiased applicant pool subject to the representative set of admissions officers, ranging from those whose admissions related decisions create successful future engineers to those whose decisions are unlikely to create future engineers.

The paper hypothesizes that, in general, most of the fields that constitute an application are composed of mathematics-related fields. Therefore, those admissions officers with strong bias towards math are likely to reveal a stronger correlation and, thus, the selected individuals are better candidates for admissions to an undergraduate engineering program. Conversely, admissions officers with strong bias towards verbal and weak bias towards math are more likely to reveal a weak correlation.

The design of the educational beliefs of the admissions officers reflect both reality and the admissions-related experience of the second author. Although the set of beliefs are unique to each admission officer, a few of the officers, termed type I, reflect the purely math and science oriented type who place great emphasis on math and science scores only. Another set of officers (type II) reflect the type that place strong emphasis on verbal and English alone. The third set of officers (type III) emphasize values that strike a balance between the science and math achievement and the applicant's parental support which, in turn, is reflected by the parents' educational background. The second author's personal experience at Brown reveals that the third type of admissions officers admit applicants that are most likely to succeed in engineering followed by the first type of officers while those selected by the type II officers are least likely to succeed in engineering.

In this study, a total of 20 officers are selected, characterized by specific philosophies, and they constitute a representative set of engineering admissions officers.

First a list of the fields along with the maximum and minimum possible values, is created. While the standardized test scores range from 200 to 800, the AP test scores vary between 1 and 5, and the traditional GPA ranges from 0.0 to 4.0 for straight As. The recommendations letters are scored from a low of 1 to a high of 5. The class rank is assumed to vary from 1 to 99. The colleges attended and degrees earned for both parents and siblings are rated from 1 through 5, with 5 referring to the best universities in the nation and the highest degree (Ph.D., M.D., D.B.A., LL.D., or equivalent), respectively.

3. Correlation Results and Analysis

As indicated earlier, a total of 10,000 applicant profiles are synthesized wherein the value of each of the relevant factors is determined stochastically. The deliberate choice of the large number of applicants aims at providing confidence in the correlations and the results of this investigation. Indeed, the ``level of significance," associated with the correlation values, are given by alpha = 0.01 implying that the correlations are statistically ``significant." The applicant pool also constitutes a representative and unbiased applicant pool, presumably including all types of college applicants.

Every officer maintained a list of 27 beliefs, each corresponding to a field of the applications. The criteria includes an applicants SAT cores, ACH score, background, etc.

Thus, in this investigation, college applications are modeled through 27 representative criteria while admissions officers are modeled by their belief structure, i.e. their individual beliefs in the relative importance of each of the 27 fields, derived from their own and the relevant university's education philosophies. Of the 27 beliefs, 15 are math oriented, 7 verbal oriented, and 6 are family background oriented, while the last one falls under a miscellaneous category. Given that an overwhelming number of the 27 beliefs are mathematically oriented, this paper projects that admission officers with math emphasis would yield higher correlation values relative to those with other emphasis.

For officers 0 and 1, both highly math oriented, the correlation coefficients are 0.925, reflecting strong correlation between the processed and raw scores. For officers 2 and 3, both verbally oriented, the coefficients are 0.8 and 0.76 respectively -- significantly lower than those for the math oriented officers. The coefficients for officers 4 and 5, who favor math and verbal abilities, are relatively high at 0.87. In contrast, the coefficients for officers 6 and 7, both of whom emphasize only the family background, are 0.770 and 0.771 respectively. While officer 8's beliefs for all of the fields are uniformly low, those for Officer 9 are consistently 1. Clearly, the raw and processed scores for Officer 9 track one another, generating a correlation coefficient of unity, while that for Officer 8 is 0.88. Given the uniform beliefs of the officers across all fields and the lack of discrimination between them, the two latter coefficients do not convey meaningful insight into the admissions process. The coefficients for officers 10 and 11, both of whom emphasize math, verbal, and family background, reflect high correlation values of 0.986 and 0.987, respectively. For Officers 12 and 13 who place strong emphasis on math and family background, the correlation values are consistently high -- 0.92 and 0.91. For Officers 14 and 15, who emphasize verbal and family background, the correlation values are relatively lower, at 0.835 and 0.76 respectively. Each of the officers 16 through 19, emphasize a single criteria, namely GPA, class rank, school reputation, and SAT math, respectively. The correlation coefficients are consistently low, ranging from 0.24 to 0.26. Clearly, reliance on a single criteria, regardless of whether it relates to math or verbal ability, may be unwise for the purpose of admission decisions. Colleges and universities are therefore justified in requiring comprehensive information on the applicants including the different criteria enumerated in this paper.

The correlation results corroborate this paper's hypothesis in that a predominant number of the fields that constitute an application are composed of mathematics-related fields. ACH scores in Math, Physics, and Chemistry, and many of the other criteria require extensive mathematical manipulation and knowledge. The corroboration probably underscores the fact that mathematical manipulation plays a surprisingly strong role in today's society. It has also been the second author's experience that officers with math emphasis are the predominant evaluators of engineering applications at Brown University and, informal tracking of students from admission through graduation reveals that these officers are the most successful ones in correctly predicting future engineers. Therefore, the results provide credibility to this paper's suggestion that, to generate early initial evaluations and to assist in the admission process, the admission officers may carefully record their belief structures, normalize the field values of the applications, and generate and analyze the processed scores. Unless the officer's belief values are uniform, the admission process may assign reasonable confidence in the analysis of the processed scores.

4. Conclusions

This paper has presented a model of the admission process in terms of the applications that encapsulate the characteristics of the applicants and the admissions officers that capture the educational philosophy of the university or college. It has described a correlation-based, scientific study to evaluate the proposed model, wherein the parameter design reflects the knowledge and experience acquired during the second author's tenure as an advisor to the undergraduate admissions office for the Sc.B. engineering program at Brown University between 1989 and 1992. Analysis of the correlations reveal that (1) admission officer biases play a strong role in determining the admission decision outcomes, (2) applicants with strong math ability, indicated through high math achievement test score, high physics achievement test score, strong parental educational background, high grade point average, and outstanding teacher recommendations are favored by the representative type of admissions officers who evaluate Sc.B. engineering applicants to Brown University, (3) reliance on a single criteria relative to the admission decision may be unwise, (4) universities

and colleges are justified in requiring comprehensive information on the applicants, and (5) SAT scores play a surprisingly minor role in the admission decision. The findings corroborate well with actual experiences of the second author.

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