PsychNology Journal, 2013
Volume 11, Number 1, 67 – 90

A Study of Admissions Software for Achieving Diversity

Juan E. Gilbert[1*], Andrea E. Johnson[1]

[1]Human-Centered Computing Division
Clemson University, Clemson, SC

ABSTRACT

In the face of legal and social challenges to affirmative action, many schools and programs are withdrawing from their efforts to create or support initiatives that allow racial/ethnic consideration to be given to applicants. This shift may allay fears of bias against majority groups but it also has the potential to disenfranchise some students and programs and leave them without the programs that help create opportunities and diversity at institutions of higher learning. This study examines the use of a software package, Applications Quest, as a possible alternative to aid admissions committees in providing clear, equitable, and reproducible policies in admissions processes. Rather than focus exclusively on race, Applications Quest creates a measure of "holistic diversity" that allows equal weight to many factors that contribute to a more diverse student population. A major research university in the South, Experiment University (EU) was enlisted to see if Applications Quest could produce a pool of applicants with the same academic achievement levels as the EU admissions selection committee while increasing holistic diversity using the requirements set forth by the committee. The results of the study show that Applications Quest was able to recommend a more diverse applicant pool than the EU admissions selection committee while meeting the same academic achievement levels in a fraction of the time using the same academic criteria.

Keywords: *admissions software, diversity, holistic review, affirmative action, preferences*

Paper Received 02/09/2012; received in revised form 11/04/2013; accepted 12/04/2013.

1. Introduction

Technology has always been an important part of social considerations regarding democracy. Leo Marx (1987) notes that during the enlightenment, technological progress was used as a metaphor for the ways that society might achieve moral progress. But he also warns that over time, the term "progress" gradually took on an increasingly technocratic character, such that today leaders often celebrate purely technological changes as "progress" with little regard for its social consequences. This project was created in opposition to that trend: it is a modest attempt to begin with a

Cite as:
Gilbert, J., & Johnson, A. (2013). A Study of Admissions Software for Achieving Diversity
. *PsychNology Journal, 11*(1), 67 – 90. Retrieved [month] [day], [year], from www.psychnology.org.

*Corresponding Author:
Dr. Juan E. Gilbert
Clemson University, 100 McAdams Hall, Clemson University, SC 29634
E-mail: juan@clemson.edu

difficult issue in social justice, and to ask how technology can be designed as an aid to creating a more equitable society. Specifically, we consider the matter of affirmative action in college admissions, and examine the potential for using a particular software application we have developed as a way to address some of its legal and political challenges.

While we are aware of the fallacy of a "technofix"—the naïve belief that some technology will automatically produce a magic solution—and recognize that any technology can have unpredicted outcomes (Tenner, 1997), we believe that designing quantitative technologies to contribute to social justice should be a crucial part of our "toolkit" in constructing a more equitable society. Haraway (1997) notes that this has been a contentious issue in Science and Technologies Studies: she contrasts Porter's (1994) condemnation of quantitative objectivity—substituting statistical expertise for face-to-face community—with her own convictions:

> I believe that the history of struggle to recraft and stabilize public realities as part of learning to put together general policies from the analytic, imaginative, and embodied standpoint of those who inhabit too many zones of unfreedom and yearn toward a more just world shows "impersonal," quantitative knowledge to be a vital dimension of moral, political, and personal reflection and action. (p. 200)

Thus the software examined in this paper is significant not only for its specific potential in addressing the problem of affirmative action, but also in how it opens more general questions regarding the design of ethically proactive technologies.

The term "affirmative action" made its first legal appearance in President John F. Kennedy's Executive Order 10925 (6 March 1961). During the Nixon administration, affirmative action was adopted as a federal mandate for companies with federal contracts and for labor unions whose workers were engaged in those projects; in some cases using strict quotas and timetables to combat deeply entrenched discrimination. By the early 1970s many universities had adopted similar measures in their admissions, and in 1974 the California State Legislature passed a resolution ordering the University of California to match the racial composition of its student body to that of each year's graduating high school class by 1980.

In 1978, the famous Bakke case defeated the California law: the US Supreme court ruled 5 to 4 that the school should admit Bakke, and further stated that schools could

no longer use racial quotas, though it left open the consideration of race in admissions to promote diversity (Dreyfuss, 1979). Nearly thirty years later no concrete solution has solved the problem of equality and fairness in the admissions process or other areas where affirmative action policies are present. Even in community colleges where underrepresented groups thrive due to affirmative action policies, the tension is still felt because "an open door does not necessarily equate to open access." (Zamani-Gallaher, 2007, p. 242)

Tensions often rise when traditionally majority students seek financial aid opportunities only to find they do not meet the qualifications of special population scholarships. Only after two landmark cases, Gratz v. Bollinger (Gratz vs. Bollinger, 2003) and Grutter v. Bollinger (Grutter vs. Bollinger, 2003), went to the U.S. Supreme Court did a profound and explicit idea of how affirmative action should be used and its goals achieved become clear. In Grutter v. Bollinger, a white Michigan resident with a 3.8 GPA and 161 LSAT score filed a suit, alleging that respondents had discriminated against her on the basis of race (Grutter vs. Bollinger, 2003). The U.S. Supreme Court stated that a program "may consider race or ethnicity only as a "'plus' in a particular applicant's file," but it must be "flexible enough to consider all pertinent elements of diversity in light of the particular qualifications of each applicant, and to place them on the same footing for consideration." It refers to this assessment as a "holistic review."

An examination of the term "holistic" in this Supreme Court case illuminates the significance of our research for Science and Technology Studies. In some passages, the term is implied to be referring to a subjective or purely qualitative approach: "[T]ruly individualized consideration demands that race be used in a flexible, nonmechanical way" (Grutter, 539 U.S. at 337). In that sense, the decision seems to imply that any quantitative approach would be unconstitutional—essentially making a technological solution illegal. Eglash (2009) reviews the underlying philosophical assumptions that result in such restrictions; this instance would fall under the category of "romantic organicism," a barrier to merging science and technology with social justice created by framing human subjectivity as the natural and exclusive grounds of morality.

However an alternative interpretation of the term "holistic" also appears in the court decision. As explained by Justice Souter: "[s]ince college admission is not left entirely to inarticulate intuition, it is hard to see what is inappropriate in assigning some stated value to a relevant characteristic, whether it be reasoning ability, writing style, running speed, or minority race." (Gratz, 539 U.S. at 295). On the whole, the court decision

language leaves the door open for a quantitative interpretation: “holistic review of each applicant’s file, giving serious consideration to all the ways an applicant might contribute to a diverse educational environment” will ensure “that all factors that may contribute to diversity are meaningfully considered alongside race” (Grutter vs. Bollinger, 2003). Thus the judgment justifies the use of a quantitative approach to affirmative action as long as each applicant is holistically evaluated; that is, as long as equal weight is given to all factors relevant to diversity. This judgment, however, does not address the issue of holistic review or capacity. How do you holistically evaluate an application without giving preference to race or ethnicity over other categories, and still achieve the kinds of diversity that are socially significant?

Holistic evaluation in its current state involves several members of a committee reviewing and ranking each application. It takes into consideration academic and personal achievement but in the words of a director of admissions at the University of California at Santa Barbara “no one thing is going to get you in, and no one thing is going to get you out.” (Foderaro, 2009) At some institutions like Columbia University, “every application is read in its entirety by at least two admissions officers before a final decision is rendered.” (York, 2010) This method is subjective by nature and does not yield reproducible recommendations. Reproducible recommendations are achieved when a separate committee or the same committee can reproduce the same recommendations during a second review with the same applicant pool after a period of time. If there is no guarantee that the same results will be reproduced, then the selection process is considered to be highly subjective and the results are not reproducible as defined here. “For large public institutions, the shift is labor-intensive and expensive.” (Foderaro, 2009) While many institutions are adopting this new holistic model they are finding it still presents a greater problem. Ideally all applicants being considered will meet a minimum qualification for admissions but many institutions are finding that the number of qualified applicants is dramatically increasing each year in comparison to the number of slots open for admission. This is called the *Capacity Issue*. The current model of holistic evaluation suffers from the Capacity Issue and has to turn away qualified applicants when the results aren’t reproducible. Here’s an example scenario:

> Given two teams of admissions officers all trained on the same holistic review process, 200 academically qualified applications with varying grade point averages, standardized test scores, achievements, etc., and 20 admissions

> slots; will the two teams select the same 20 applications for admissions? If not, how do you choose which applications to turn away? If there is no guarantee that the two teams will reach the same decisions when they have received the same training, the process is not scientific, it's subjective at best; therefore, it is not reproducible. (Gilbert & Lewis, 2008, p.3)

In theory, the current model of holistic evaluation works; however, the results are not reproducible. If the results cannot be reproduced or proven by objective means, there can be grounds for objection or legal reproach because qualified applicants are turned away and they can make a case against the selection committee. For example, in 2006 student Jian Li filed a civil rights complaint against Princeton University

> alleging that the college did not accept his application for enrollment because he is Asian American. His case is based on a study of admissions processes by three Princeton researchers in 2004, that found elite universities giving African American and Hispanic students an advantage equivalent with extra SAT points while placing Asian American students at a disadvantage by deducting SAT points. (Wang & Chow, 2006)

Princeton does not make decisions solely on academic achievements but without a process to reproduce or validate their selections they become vulnerable to future complaints of "disaffirmative action" (Wang & Chow, 2006) A more scientific approach to holistic evaluation would ensure that students receive a fair and justifiable method of review and institutions would benefit from reproducible results and neutralize legal challenges.

2. Applications Quest

Based on the two landmark University of Michigan cases and the evident problems facing holistic evaluation, the idea of using technology to compare a set of applications to one another and identifying their differences as a means to make recommendations was born. Applications Quest is a data mining and analysis software tool that facilitates holistic review in admissions, school placement and academic support programs. The underlying concept behind Applications Quest is holistic comparisons of applications.

2.1 Description

Applications Quest uses a data-mining algorithm where holistic review is accomplished by measuring the difference between applications based on the attributes selected by the review committee. We can think of each attribute comparison as a measurement of proximity. For example, if Application A is from a lower income bracket, and Application B is from an upper income bracket, those two applicants are "farther apart" than two from the same income bracket. In the case of numerical data, the difference can be literally measured as distance: we can think of numeric attributes like income as creating an N-dimensional space where N represents the number of attributes and each application can be represented by a single point. The distance between points is their difference with respect to diversity of numeric attributes like income. Applications also include non-numeric or nominal attributes. The attribute "major" on an application is nominal: thus two applicants with the same major will be "closer" than two with different majors (if all else is equal). Humans are not very good at summarizing distances using dozens of numeric dimensions, let alone integrating them with nominal data differences, but computers have no significant barriers in this regard. Thus Applications Quest allows applications to be compared across multiple numeric and nominal attributes. Using this notion, all qualified applications are compared to every other qualified application, which would result in a difference matrix (see Table 1).

	Applicant 1	**Applicant 2**	**Applicant 3**
Applicant 1	**0%**	**30%**	**70%**
Applicant 2	**30%**	**0%**	**50%**
Applicant 3	**70%**	**50%**	**0%**

Table 1. Sample Difference Matrix

The difference matrix contains application pairs and their measured difference. Using this difference matrix, it is easier to see what we mean by the idea that some applications are more similar than others. If the difference matrix were mapped onto paper where each application was represented by a point, there would be groups or clusters of applications, such that the applications within a specific cluster are more similar than those outside of the cluster. Essentially, these clusters represent holistically diverse applicant pools and can facilitate holistic review. By selecting applications from each cluster, holistic diversity can be optimized. Holistic diversity can be defined here as multifaceted variation among applicants, where the goal is to increase minority representation across a number of attributes, where "minority" refers

to the values within an attribute, not race or ethnicity. For example, if physics majors, men, low income and first generation students are all minorities with respect to their attributes within the applicant pool, holistic diversity refers to an increase in their representation in the admitted group compared to their representation in the applicant group.

2.2 The 3 Phase Admissions Process

Within this study, Applications Quest was incorporated into a 3-phase admissions process. The 3-phase admissions process was used to address the aforementioned *Capacity Issue*. Recall that there are a limited number of slots available for admissions. Using this as the core component in admissions, the 3-phase admissions process directly addresses the capacity issue. The first phase of this process is the *Automatic Admit Phase*. The Automatic Admit Phase consists of privileged students that get immediate acceptance, i.e. highest test score requirements, athletes, or any other legitimate preference that would automatically admit these students. These students are admitted and they take up a specific number of admissions slots from the limited available slots. Upon completion of Phase one, the number of available slots has been reduced and so there are more applicants than there are slots to fill. Phase two is the *Qualified Applicants Phase*, where the admissions committee sets a bar or a set of standards by which all applicants are deemed qualified. If the applicants do not meet the bar they are rejected. These set of standards are predetermined by the admissions committee and typically represent what each applicant should have as a minimum (i.e. Test scores and/or grade point average) to be qualified for admissions. Hence, all the qualified students are equally qualified. There is no notion of one student being more qualified than another. If such a notion exists, the admissions committee will simply move the bar or set the minimum qualifications requirements higher, such that there is no notion that one qualified student is more qualified than another. The final phase is the *Applications Quest Phase* where applications that meet the admissions bar but are not automatic admits are processed in Applications Quest to fill the remaining admissions slots left by the automatic admits students. Using this 3-phase process, it is hypothesized that admission programs are able to select those applicants who meet the admissions bar, i.e. qualified applicants, while optimizing holistic diversity and adhering to the law, i.e. no preferences to race/ethnicity, gender or national origin.

3. Experiment University Case Study

3.1 Total Applicant Pool

In an effort to evaluate the effectiveness of the Applications Quest model, a case study was done at Experiment University (EU) that compared an admissions selection committee's results to Applications Quest. The goal of the study is to observe if Applications Quest could meet the standards of an admissions selection committee while fulfilling the requirements of objectivity and reproducibility while increasing holistic diversity. The collective group of 2,550 students was placed into Applications Quest to obtain their *Difference Index*. Recall that Applications Quest compares every application to every other application to create a difference matrix, see Table 1. The difference index is calculated by taking the average difference between all the comparisons. Specifically, this would be accomplished by taking the average of the Difference column in Table 1. The applicant pool had a difference index of 41.99%, meaning the group of applications was approximately 42% different from one another. The population consisted of 1,379 female and 1,171 male applicants with 15% being first generation applicants. First generation students are those whose parents never enrolled or successfully completed a post-secondary education. The average grade point average (GPA) of the population was 3.26 and the average ACT score was 22.10. Of the 2,550 applicants, 85% were designated as White, 9.65% as Black, 2.12% as Hispanic, 1.69% as other, 1.10% as Asian and less than 1% as Native American. The EU admissions committee selected 434 applicants for admissions. Those 434 applications had a difference index of 40.32%, which is less than the difference index for all 2,550 applications (41.99%), indicating they selected applicants who were holistically less diverse than the entire applicant pool. Therefore, the applicant pool was holistically more diverse than those selected by the admissions committee. The EU admissions committee selected applications consisted of 238 female and 196 male applicants. 11% of those selected were first generation students. The average GPA of the selection committee's selected applications was 3.51 and the average ACT score was 23.35. The racial breakdown was 83.87% White, 10.60% Black, 1.15% Hispanic/Latino, 2.07% other, 1.61% Asian, and less than 1% Native American. After identifying the attributes or characteristics of interest, the admissions selection committee used Applications Quest to process the applicant pool for 434 applications. Grade Point Average (GPA), ACT, Gender, Legacy, Ethnicity, Major, Low Income Status, First Generation Status and Home State were the attributes used by

Applications Quest to perform the clustering in the experiments described below. Applications Quest was set to recommend the holistically most unique or diverse application from each cluster; therefore, 434 clusters were created and one application was recommended for admissions from each cluster. Applications Quest selected 434 applications with a difference index of 46.01%; this is higher than both the EU selected applications and the difference index for the entire applicant pool, see Table 2. 70 of the applications, or 16.1%, recommended by Applications Quest were also chosen by the EU admissions selection committee.

	Applicant Pool	**EU Applications**	**AQ Applications**
Difference Index	41.99%	40.32%	46.01%

Table 2. Difference Index for All Applicants, EU Recommended Applicants and AQ Recommended Applicants

Although Applications Quest produced a higher difference index than the EU admissions selection committee, an attribute breakdown analysis was done to compare the EU selections versus the Applications Quest recommendations.

In Table 3, the grade point average (GPA) attribute analysis shows the average, minimum, and maximum GPAs of the applicants as chosen by the EU admissions selection committee and Applications Quest versus the applicant pool. Applications Quest chose 434 applications that had an average GPA of 3.26 whereas the EU admissions selection committee chose applicants whose GPA averaged 3.51. The overall average for all applicants is the same as Applications Quest suggesting that the EU admissions selection committee may have favored those applications with higher GPAs.

	Average	**Max**	**Min**
Applicant Pool	3.26	5.64	2.26
EU	3.51	5.64	2.65
AQ	3.26	5.07	2.29

Table 3. GPA Analysis

In Table 4, the ACT attribute analysis shows the average, minimum, and maximum ACT scores of the applicants from EU admissions selection committee and Applications Quest versus the applicant pool. Applications Quest selected applications with an average ACT score of 22.13 while the admissions selection committee

selected those applicants with a higher average score of 23.35. As with the GPA analysis, Applications Quest's average ACT score ranked very closely in line with the average of the total applications.

	Average	**Max**	**Min**
Applicant Pool	22.10	32.00	16.00
EU	23.35	30.00	17.00
AQ	22.13	32.00	16.00

Table 4. Average ACT Analysis

Table 5, shows the breakdown of gender in the selections by the EU admissions selection committee and Applications Quest versus the applicant pool. The EU admissions selection committee chose approximately 45% male applicants while Applications Quest chose approximately 48%. Overall, the male applicants were the minority (45.92%) in the applicant pool; however, Applications Quest made selections that increased the male applicants' representation in the recommended applicant pool. In other words, Applications Quest increased gender diversity compared to the EU selection based on the overall applicant pool.

	Applicant Pool	**EU**	**AQ**
F	1379 (54.08%)	238 (54.84%)	224 (51.61%)
M	1171 (45.92%)	196 (45.16%)	210 (48.39%)

Table 5. Gender Analysis. Key: F = Female, M = Male

Table 6 shows a breakdown of the ethnicities selected by each group. Ethnicity is defined as how the individuals designated themselves on the application form. From the initial set of applications the majority of applicants were White (85.02%). Applications Quest was able to increase the selections of more minority groups than the EU admissions selection committee. Applications Quest increased the representation of five of the six Ethnicity groups, Black, Native American, Hispanic, Asian and Other, in the recommended applicant pool where the EU selection committee only increased the representation of four of the six groups, Blacks, Native

Americans, Asians and Other. Overall Applications Quest was able to increase ethnic diversity among the applicants more than the selection committee.

	Applicant Pool	**EU**	**AQ**
B	246 (9.65%)	46 (10.60%)	53 (12.21%)
H	54 (2.12%)	5 (1.15%)	15 (3.46%)
I	11 (0.43%)	3 (0.69%)	2 (0.46%)
O	28 (1.10%)	7 (1.61%)	11 (2.53%)
W	2168 (85.02%)	364 (83.87%)	341 (78.57%)
X	43 (1.69%)	9 (2.07%)	12 (2.76%)

Table 6. Ethnicity Analysis
Key: B=Black, H=Hispanic, I=Native American, O=Asian, W=White, X=Other

In Table 7, the low-income attribute is analyzed for the two groups, low income or not. Low income is defined as the inability to cover one's educational expenses without financial assistance. The EU admissions selection committee chose approximately 8% of the applicants who were considered low income while Applications Quest chose approximately 10%. Both groups chose a ratio higher than that of the original total population (6.59%). This is important because it suggests that in both groups, students that perhaps may not have been given a chance otherwise for admission would be given an opportunity.

	Applicant Pool	**EU**	**AQ**
N	2382 (93.41%)	399 (91.94%)	391 (90.09%)
Y	168 (6.59%)	35 (8.06%)	43 (9.91%)

Table 7. Low Income Analysis. Key: N = No, Y = Yes

Table 8 reflects the breakdown of the first generation applicant selections. In the initial population, 14.94% were first generation applicants. The EU admissions selection committee selected 11.06% of the selected applicants as first generation whereas Applications Quest recommended more than twice the EU selection committee with 26.96% of the recommended applications as first generation.

	Applicant Pool	EU	AQ
N	2,169 (85.06%)	386 (88.94%)	317 (73.04%)
Y	381 (14.94%)	48 (11.06%)	117 (26.96%)

Table 8. First Generation Analysis. Key: N = No, Y = Yes

As a whole, Applications Quest increased holistic diversity, as defined by the U.S. Supreme Court, better than the EU admissions committee, i.e. Applications Quest produced more balance across all attributes relative to the applicant pool. Although Applications Quest has increased holistic diversity in its application choices, the EU admissions selection committee had selected applicants with higher academic achievement levels, i.e. higher GPAs (3.51 vs. 3.26) and ACT scores (23.35 vs. 22.13) than Applications Quest. After this observation was made, a second study was conducted with the same applicant pool to see if Applications Quest could achieve the same academic achievement levels as the selection committee while increasing holistic diversity.

Additional analysis by the Applications Quest team was conducted on the EU admissions committee's selections. It was observed that 49% of the EU applicants had a 3.5 GPA or higher and the lowest GPA of any admitted student was a 2.65. The lowest chosen GPA by the EU committee was 2.65, therefore 2.65 was used as an acceptable minimum GPA score for phase two. Using this information, the Applications Quest team used the minimum GPA and ACT score requirements to establish a minimum qualifications bar. As such, the original applicant pool was divided into three groups, those with a 3.5 GPA or higher and an ACT score of 17 or higher (subgroup 3.5 GPA); a GPA less than 3.5, but greater than or equal to 2.65 and an ACT score of 19 or higher (subgroup 2.65 GPA); and those that did not meet either of these requirements. Those failing to meet the requirements of the first two groups were removed from consideration.

3.2 Subgroup 3.5 GPA

The first subgroup contained those applicants that had a 3.5 GPA or higher and an ACT score of 17 or higher. There were a total of 708 applicants that met this qualification and together they yielded a difference index of 42.64%. The EU admissions selection committee chose 213 (49%) applicants from this group for

admission with a difference index of 39.54% while Applications Quest selected 213 applications with a difference index of 45.58% from this subgroup. Between both groups (EU selection committee and Applications Quest) there were 70 applications (32.9%) in common. For this population, applicants with GPAs of 3.5 or higher and ACT scores 17 or higher, Applications Quest was able to recommend a more holistically diverse group of applications versus than the EU selection committee, see Table 9.

	3.5 Subgroup	**EU Applications**	**AQ Applications**
Difference Index	42.64%	39.54%	45.58%

Table 9. Difference Index for Subgroup 3.5 GPA or higher, EU Recommended Applicants and AQ Recommended Applicants

Table 10 illustrates the GPA attribute analysis of the 3.5 subgroup selected by the EU admissions committee and Applications Quest with the average, minimum, and maximum GPA scores shown. The EU admissions selection committee selected a group of applicants whose average GPA was higher than that of Applications Quest and the total population but this time Applications Quest was only .03 of a point less. Both groups did manage to select groups with GPAs higher than the average of 3.78 for the total subgroup population.

	Average	**Max**	**Min**
3.5 Subgroup	3.78	5.64	3.50
EU	3.82	5.64	3.50
AQ	3.79	5.64	3.50

Table 10. GPA Analysis for Subgroup 3.5 GPA or higher

Table 11 contains the ACT attribute analysis with the average, maximum and minimum scores being reported for this subgroup. In this group, the EU selection committee selections had an average ACT score of 23.32 while Applications Quest had an average ACT score of 21.45. Both groups had an average ACT score higher than the overall population (21.16); however, the EU selection committee had the highest average ACT score, nearly 2 points higher than Applications Quest.

	Average	Max	Min
3.5 Subgroup	21.16	27.00	17.00
EU	23.32	27.00	17.00
AQ	21.45	27.00	17.00

Table 11. Average ACT Analysis for Subgroup 3.5 GPA or higher

The gender analysis in table 12 shows an improvement in the number of male applicants for both the EU admissions selection committee and Applications Quest. The original subgroup population contained approximately 33% male applicants and respectively the EU admissions selection committee chose an increased 37.09% and Applications Quest selected 38.50%. With respect to Gender for this subgroup, Applications Quest slightly outperformed the EU selection committee.

	3.5 Subgroup	EU	AQ
F	476 (67.23%)	134 (62.91%)	131 (61.50%)
M	232 (32.77%)	79 (37.09%)	82 (38.50%)

Table 12. Gender Analysis for Subgroup 3.5 GPA or higher
Key: F = Female, M = Male

Table 13 shows an ethnicity attribute breakdown selected by each group. Those applicants designated as White were the majority ethnic group for the initial population representing 83.90% of the qualified applicants for this subgroup. This majority representation was present in both the Applications Quest selections and the EU admissions selection committee's selections. Again, Applications Quest increased the diversity of its selections in comparison to the EU admissions selection committee. Of the six ethnicity groups, Applications Quest increased the representation of four of the groups, Hispanic, Native American, Asian, and Other while the EU selection committee only increased the representation of two of the six groups, Native American and Asian.

	3.5 Subgroup	EU	AQ
B	88 (12.43%)	24 (11.27%)	26 (12.21%)
H	10 (1.41%)	2 (0.94%)	6 (2.82%)
I	2 (0.28%)	2 (0.94%)	2 (0.94%)
O	7 (0.99%)	4 (1.88%)	5 (2.35%)
W	594 (83.90%)	179 (84.04%)	170 (79.81%)
X	7 (0.99%)	2 (0.94%)	4 (1.88%)

Table 13. Ethnicity Analysis for Subgroup 3.5 GPA or higher
Key: B=Black, H=Hispanic, I=Native American, O=Asian, W=White, X=Other

In Table 14, the low-income attribute selections for Applications Quest and the EU selection committee are reported. Applications Quest was able to increase the representation of low-income applications more than the EU selection committee. In fact, Applications Quest chose 11.74% of those applications considered low income while the EU selection committee selected a decreased representation of 7.51% low-income applicants. Overall Applications Quest increased the low-income representation from the initial population by over 2% and by over 4% in comparison to the EU selection committee.

	3.5 Subgroup	EU	AQ
N	642 (90.68%)	197 (92.49%)	188 (88.26%)
Y	66 (9.32%)	16 (7.51%)	25 (11.74%)

Table 14. Low Income Analysis for Subgroup 3.5 GPA or higher
Key: N = No, Y = Yes

The analysis in Table 15 shows the breakdown of first generation selections by the EU admissions committee and Applications Quest. The EU admissions committee chose 10.80% of the selected applicants as first generation, decreasing the number of applicants chosen as first generation applicants by almost 6% from the original subgroup population ratio of 16.38%. Applications Quest however, recommended 28.64% of the selected applications, increasing its selections of first generation applications over the EU selection committee by almost 18%. Applications Quest,

overall, was able to increase its representation in comparison to both the original subgroup population and the EU selection committee.

	3.5 Subgroup	**EU**	**AQ**
N	592 (83.62%)	190 (89.20%)	152 (71.36%)
Y	116 (16.38%)	23 (10.80%)	61 (28.64%)

Table 15. First Generation Analysis for Subgroup 3.5 GPA or higher
Key: N = No, Y = Yes

While investigating the first subgroup of the second study, Applications Quest successfully recommended applications that met and exceeded the qualifications described. Among the attributes GPA and ACT, Applications Quest still trailed closely behind the EU selection committee. From this subset of applicants the analysis above demonstrated that Applications Quest was able to produce a more diverse applicant pool with a difference index of 45.58% compared to that of the EU admissions selection committee's 39.54%. In the attribute analyses, Applications Quest selected those applications with an average GPA of 3.79 while the EU admissions selection committee chose applicants with an average GPA of 3.82. The ACT analysis also showed similar results where Applications Quest selected applications with an average score of 21.45 and the EU admissions selection committee chose those applicants with an average score of 23.32. As inherent indicators of academic success, these two attributes were very important in corroborating Applications Quest's ability to holistically evaluate applications without bias or giving preference to race and meet qualifications on indicators of academic success. The following analysis will detail the results of comparisons made between the applications chosen by the EU admissions selection committee and those selected by Applications Quest from the second subgroup of applicants with GPAs of between the range of 2.65 and 3.5 and ACT scores of 19 or higher.

3.3 Subgroup 2.65 GPA

The second subgroup contained applications with a 2.65 GPA or higher but below 3.5 and an ACT score of 19 or higher. There were a total of 1,671 applications within this group with a difference index of 42.42%. The EU admissions selection committee chose 221 applications with a difference index of 41.01% while Applications Quest selected 221 applications with a difference index of 46.98% from this second group.

Between both groups were 25 applications (11.3%) in common. Table 16 shows the difference indices for both groups; Applications Quest was able to recommend applications that were more diverse than the EU admissions selection committee's choices.

	2.65 Subgroup	EU Applications	AQ Applications
Difference Index	42.42%	41.01%	46.98%

Table 16. Difference Index for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants

In Table 17, the minimum, maximum, and average GPAs selected by the EU admissions committee and Applications Quest are shown. The EU admissions committee chose applications with an average GPA of 3.20 whereas Applications Quest selected applications with an average GPA of 3.03.

	Average	Max	Min
2.65 Subgroup	3.09	3.49	2.65
EU	3.20	3.48	2.65
AQ	3.03	3.49	2.65

Table 17. GPA Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants

Table 18 shows the ACT Analysis with the minimum, maximum, and average ACT scores of applications selected by the EU admissions committee and Applications Quest. The average ACT score of the applications selected by the EU selection team was 23.39 while the average score for Applications Quest applications was 22.33. Consistently throughout the selection process in this study the EU admissions selection committee has selected those applicants with higher average ACT scores than Applications Quest for this subgroup.

	Average	Max	Min
2.65 Subgroup	22.21	32.00	19.00
EU	23.39	30.00	19.00
AQ	22.33	30.00	19.00

Table 18. Average ACT Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants

Table 19 displays the Gender Analysis from the selections made by the EU admissions committee and Applications Quest. In this group, both genders were almost equally represented with the proportions being approximately 51% female and 49% male. The EU selection committee applications choices increased the male representation to 52.94% while Applications Quest recommendations decreased the female representation to 46.15%. The EU selection committee, in this instance, was able to improve the gender diversity of this subgroup more than Applications Quest.

	2.65 Subgroup	EU	AQ
F	844 (50.51%)	104 (47.06%)	119 (53.85%)
M	827 (49.49%)	117 (52.94%)	102 (46.15%)

Table 19. Gender Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants
Key: F = Female, M = Male

In the ethnicity breakdown presented in Table 20, those applications designated as White were the majority group at 86.59%. The EU admissions committee increased the representation of three of the six ethnic groups: Black, Asian and Other while Applications Quest increased the representation of five of six of the ethnic groups: Black, Native American, Hispanic, Asian and Other. The largest sign of increase was in the Hispanic ethnic group increasing by almost 4%.

	2.65 Subgroup	EU	AQ
B	131 (7.84%)	22 (9.95%)	19 (8.60%)
H	35 (2.09%)	3 (1.36%)	13 (5.88%)
I	9 (0.54%)	1 (0.45%)	2 (0.90%)
O	18 (1.08%)	3 (1.36%)	5 (2.26%)
W	1447 (86.59%)	185 (83.71%)	177 (80.09%)
X	31 (1.86%)	7 (3.17%)	5 (2.26%)

Table 20. Ethnicity Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants
Key: B = Black, H = Hispanic, I = Native American, O = Asian, W = White, X = Other

Table 21 displays the applicant selections made by the EU admissions committee and Applications Quest for the low-income attribute. Both groups again increased their selection of low-income applications versus the subgroup representation of low-income application. The 2.65 subgroup contained 5.21% low-income applications and both groups raised that presence by at least 3.5% with the EU committee choosing 8.60% and Applications Quest recommending 9.95%.

	2.65 Subgroup	EU	AQ
N	1583 (94.79%)	202 (91.40%)	199 (90.05%)
Y	87 (5.21%)	19 (8.60%)	22 (9.95%)

Table 21. Low Income Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants
Key: N = No, Y = Yes

Table 22 shows the first generation applications chosen by the EU admissions committee and Applications Quest. The data shows that the original subgroup proportion for first generation applications was 13.76%. Applications Quest more than doubled the representation of first generation applications in its recommendations whereas the EU admissions selection committee decreased their selections of applications to 11.31%.

	2.65 Subgroup	EU	AQ
N	1441 (86.24%)	196 (88.69%)	159 (71.95%)
Y	230 (13.76%)	25 (11.31%)	62 (28.05%)

Table 22. First Generation Analysis for Subgroup GPA Greater than 2.65 and Less than 3.5 and ACT Greater than 19, EU Recommended Applicants and AQ Recommended Applicants
Key: N = No, Y = Yes

3.4 Study Summary

In summary, after running applications through Applications Quest for the second study, the analysis of the data showed that Applications Quest was quite capable of producing results comparable to those selected by the EU admissions committee with respect to academic achievement levels. There was also evidence to show that Applications Quest was able to increase holistic diversity across multiple attributes for both subgroups versus the EU admissions committee without giving preference to any single attribute.

Based on the difference matrix presented below in Table 23, Applications Quest was better able to yield a more holistically diverse admissions pool, approximately 47% different, versus the EU admissions committee. Applications Quest was able to recommend the most diverse applications; by grouping similar applications into clusters and from those clusters of similar applications recommending the application that was most unique within the group for admission. The application still exemplifies the characteristics of its particular cluster, but what makes the application different is the variation of all the application's attributes based on the holistic comparison of all other applications.

	Both Subgroups	EU Applications	AQ Applications
Difference Index	41.99%	40.32%	46.83%

Table 23. Difference Index Containing both Subgroups (3.65 GPA and 2.65 GPA)

4. Applications Quest Summary and Discussion

4.1 Adherence to Judicial Decisions

The results of this study suggests that, at least in the case of the particular system that was evaluated in this study, it is possible to use an automated, quantitative

analysis to increase holistic diversity across multiple application attributes while maintaining academic achievement levels. Moreover, there are distinct additional advantages to that approach. First, that it takes only a fraction of the time that would be required for an admissions committee. The EU admissions committee took approximately 5 weeks to reach their selections, whereas Applications Quest took minutes less than 10 minutes to recommend a holistically diverse applicant group with similar academic achievement levels. Second, that it is producing a reproducible set of recommendations, diminishing the possibility for a legal challenge. But most importantly, the data suggests that, at least in the case of Applications Quest, admissions committees can increase holistic diversity without disenfranchising any specific group. This is essentially the goal set forth by the U.S. Supreme Court, the ability to use all attributes (including race) as a means to increase holistic diversity.

From a computing viewpoint, the software does not have "knowledge" of the attributes themselves: all parameters (race, gender, ethnicity, etc.) are simply treated as identical categories; the tool sees every attribute equally. From that perspective, its recommendations are reproducible, fair, and transparent allowing for scrutiny under legal review. In the final section, we consider how social viewpoints might intersect with that computational perspective.

4.2 On the future of automated holistic review in college admissions

What additional perspectives might be considered in regards to the use of automated holistic review software such as Applications Quest? As noted in our introduction, critiques based purely on organicism—the idea that an indefinable human subjectivity is the only basis for ethical decisions—has been found increasingly suspect by social science and humanities perspectives (Haraway, 1997; Eglash 2009). Similarly, we note that while many of the labor-based critiques of automation have important insights—David Nobel's study, for example, of the ways that automated machine tools were used for "deskilling" workers as a managerial strategy to counter unionization—they are of limited applicability here: admissions diversity committees are typically regarded as burden, not a career path (Noble, 1984). But more subtle forms of misuse are always possible.

A less obvious issue might arise around strategic use of diversity measures by students. By understanding that universities and colleges are applying a consistent holistic review for more diverse candidates, students may began to "game" the system by applying to places they might be deemed "diverse" but may otherwise not apply to.

This could be exacerbated by students using the Common App (2012), an application that allows students to submit one standardized undergraduate application to more than 400 schools, which might create an overflow for admissions committees. Again this contributes to the *Capacity Issue* that we referred to previously in this paper. However it is not clear that the overall effect would be negative: students actively working to increase diversity—even if it is in the service of self-interest—might be a desirable outcome; perhaps the stigma of diversity admissions would diminish as well.

One way to think more generally about the potential negative consequences might be in terms of Latour's (1992) framing of the "delegation" of human action to machines, which then become "non-human actors". Such delegation can displace moral responsibility: consider, for example, the question of whether or not the owners of a server can be held responsible for pirated media stored on their machines. But evasions of accountability can be diminished if we emphasize how its underlying principles can be applied to the system in question. In our case, the most important of these principles may be that of transparency; a feature that is often regarded as beneficial in technosocial relations (Jasanoff, 2006).

By making both the attributes and review process "transparent" in the sense of a matter of public record, universities could diminish their vulnerability to legal dispute. However there are various levels of transparency that could be applied. A university might choose to release a list of the attributes, but not make the algorithm public, or vice-versa. Further subtleties could be introduced, such as setting income categories, lumping or splitting ethnicities, or creating other attribute designations that might or might not be made public.

Despite these nuances, it is our contention that an automated diversity review process would offer better opportunities for transparency than that of human-only review: by definition subjectivity is not open to public scrutiny. In addition to transparency, other opportunities to fine-tune the system in accordance with principles of social justice may arise. This emphasis on a search for opportunities for "tuning" the system (Pickering 1995) is precisely what is missing in the framework of the "techno-fix" – the naïve assertion that some device will automatically cure a social ill (Drengson, 1984). Socially beneficial outcomes are not automatic; when they occur they are the outcome of designers working by trial and error to hone the ethical dimensions of their products, and a social infrastructure that allows such processes and products to flourish. We encourage the introduction of automated review technologies such as Applications Quest not as a techno-fix, but rather, in the words of

Haraway, a tool by which “quantitative knowledge” is crafted as “a vital dimension of moral, political, and personal reflection and action.”

5. References

Gratz vs. Bollinger. (2003). *539 U.S. 244, 123 S.Ct. 2411*.

Grutter vs. Bollinger. (2003). *539 U.S.306, 123 S.Ct.2325*.

Drengson, A. R. (1984). The Sacred and the Limits of the Technological Fix. *Zygon, 19* (3), 259-275.

Dreyfuss, J. (1979). *The Bakke Case: the Politics of Inequality*. New York and London: Harcourt Brace Jovanovich.

Eglash, R. (2009). Oppositional Technophilia. Social *Epistemology* 23(1), 79-86.

Foderaro, L. W. (2009, November 1). The Whole Applicant. *The New York Times*; ED25. Retrieved May 4, 2013 from http://www.nytimes.com/2009/11/01/education/edlife/01admission-t.html?pagewanted=all.

Gilbert, J. E., & Lewis, C. W. (2008). An Investigation of Computational Holistic Evaluation of Admissions for a Minority Focused STEM Research Program. *Journal of STEM Education*, *9*(1), 1-8.

Haraway, D. (1997) Modest_Witness@Second_Millennium: Female_Man©_Meets_Oncomouse™ , London & New York: Routledge.

Jasanoff, S. (2006). Transparency in Public Science: Purposes, Reasons, Limits. *Law & Contemporary Problems 69,* 21- 34

Latour, B. (1992). Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts. In W. Bijker & J. Law (Eds.), *Shaping technology/building society: Studies in sociotechnical change* (pp. 225–258). Cambridge, MA: MIT Press.

Marx, L. (1987). Does improved technology mean progress? Understanding the historical distinction between two contradictory concepts of progress helps explain the current disenchantment with technology. *Technology Review*, *71*, 33-41. Retrieved January 27, 2013, from http://www2.technologyreview.com/magazine/magpdfdownload.aspx?s=T&id=450

Noble, D. F. (1984). *Forces of production: a social history of industrial automation*. New York: Knopf.

Parker-Pope, T. (2008, May 6). Psychiatry handbook linked to drug industry. The New York Times. Retrieved from http://well.blogs.nytimes.com

Pickering, A. (1995). *The Mangle of Practice: Time, Agency, and Science*. Chicago: University of Chicago Press.

Porter, T. (1995). *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life.* Princeton University Press, Princeton NJ.

Tenner, E. (1997). *Why things bite back: technology and the revenge of unintended consequences*. New York: Knopf.

‘‘The Common Application: All Members". Retrieved March 12, 2013, from https://www.commonapp.org/CommonApp/Default.aspx.

Wang, J., & Chow, K. (2006, November 15). Anti-Asian bias alleged. *Yale Daily News*. Retrieved May 4, 2013 from http://www.yaledailynews.com/news/2006/nov/15/anti-asian-bias-alleged/

York, T. T. (2010). *What Does Columbia Look For In a Candidate?* Retrieved May 4, 2013 from http://www.studentaffairs.columbia.edu/admissions/applications/firstyear/overview

Zamani-Gallaher, E. M. (2007). The Confluence of Race, Gender, and Class Among Community College Students: Assessing Attitudes Toward Affirmative Action in College Admissions. *Equity and Excellence in Education40*(3), 241-251.