

Expanding Access to Higher Education: The Case for Using Minority Quotas or Reserves to Increase Diversity

Yanbing Wang^{1,a,*}

¹*School of Social Sciences, The University of Manchester, Manchester M13 9PL, UK*
a. yanbing.wang-2@student.manchester.ac.uk

**corresponding author*

Abstract: This project report aims to explore the use of minority quotas or minority reserves as a means of increasing diversity in university admissions and widening access. The report provides a critical review of the literature on this topic, outlines the benefits and drawbacks of using quotas and reserves, and presents a mathematical model which introduces a fairness constraint to the Men-proposing Deferred Acceptance (DA) Algorithm to address the issues of underrepresented minority groups and promote diversity in the college admissions process. The model is used to match students and schools in a way that maximizes diversity while maintaining fairness and efficiency. This report provides proof and computational results to demonstrate the effectiveness of our approach. The report draws on Alvin E. Roth's "The Art of Designing Markets" to underscore the importance of designing effective market mechanisms that address the challenges of diversity and equity in university admissions. The report concludes that minority quotas and reserves can be effective tools for promoting diversity and social justice in higher education, but that they must be implemented carefully and in conjunction with other policies aimed at addressing structural inequalities.

Keywords: diversity and inclusivity, minority quotas or reserves, matching markets

1. Introduction

Diversity and inclusivity are essential elements for creating a fair and just society. In today's world, where access to education is crucial for social and economic mobility, ensuring diversity in university admissions is vital. College admissions and marriage stability problems were first studied by David Gale and Lloyd Shapley in 1962, and matching algorithms have since been widely used in a variety of applications, including college admissions [1]. Abdulkadiroglu and Sonmez have also made significant contributions to the theory and practice of matching markets in their book, which provides a comprehensive overview of the field [2]. The benefits of diversity in higher education are numerous and have been widely documented, including improved cognitive outcomes, increased civic engagement, and enhanced intergroup relations. However, despite various efforts to promote diversity, many universities still cannot achieve their target of providing a diversified culture for students. One approach that has been proposed to address this issue is the use of minority quotas or minority reserves. These are policies that aim to reserve a certain number or percentage of places for underrepresented groups, such as students from ethnic minorities, students from low-income households, or students with disabilities. The use of such policies has been a subject of debate, with proponents arguing that

it is an effective way to increase diversity in university admissions and widen access to education, while opponents question the fairness and effectiveness of such policies.

This paper will explore the use of minority quotas and minority reserves in university admissions and their potential impact on diversity and access to education. We will discuss the existing literature on this topic, the technical aspects of implementing such policies, and the potential benefits and drawbacks of using these policies in practice. This report aims to evaluate the effectiveness of such policies and to provide a mathematical model called the Fairness-constrained Deferred Acceptance (DA) Algorithm Model for optimizing the allocation of places in universities. This study aims to investigate the problem of diversity and equity in college admissions. Our investigation is driven by the gap in the literature concerning the limited effectiveness of traditional college admissions processes in promoting diversity and equal opportunity. We will focus on the following research questions:

(1) What are the benefits and drawbacks of using minority quotas or minority reserves in university admissions?

(2) How effective is the Fairness-constrained Deferred Acceptance (DA) Algorithm in promoting diversity and equal opportunity in college admissions, compared to traditional admissions processes?

(3) What are the key limitations of the Fairness-constrained DA Algorithm, and how do they impact its usefulness in practice?

(4) How can the Fairness-constrained DA Algorithm be improved to better promote diversity and equal opportunity in college admissions?

One of the benefits of using minority quotas or reserves is that it can increase the representation of underrepresented groups in higher education. This can provide opportunities for minority students who may have been overlooked due to socio-economic barriers or discrimination. However, there are also several drawbacks to using minority quotas or reserves. One concern is that it may lead to reverse discrimination, where more qualified non-minority applicants are overlooked in favor of less qualified minority applicants. This can lead to resentment and tension among students and can also undermine the credibility of the university's admissions process. Furthermore, there is a risk that minority students may be stigmatized or stereotyped as being admitted solely because of their race or ethnicity, rather than their qualifications and achievements.

To answer research questions about the mathematical model, we will conduct a thorough review of the literature on diversity and equity in college admissions, as well as traditional admissions processes and the limitations of these processes. We will then introduce the Fairness-constrained DA Algorithm and compare its effectiveness in promoting diversity and equal opportunity in college admissions to traditional admissions processes. We will also analyze the limitations of the Fairness-constrained DA Algorithm, particularly in terms of its potential impact on student preferences and institutional constraints. Finally, we will discuss potential improvements to the Fairness-constrained DA Algorithm, such as incorporating additional constraints and preferences into the algorithm. Our investigation will contribute to the ongoing debate on social justice, equality, and opportunity in higher education and provide insights into the potential of algorithmic approaches to promoting diversity and equity in college admissions.

2. Literature Review

The literature on minority quotas and reserves is extensive and covers a wide range of disciplines, including economics, political science, sociology, and education. Supporters argue that they are necessary to address historical and ongoing discrimination and to promote social justice. Critics, on the other hand, argue that they can be unfair, divisive, and ineffective in achieving their intended goals. In recent years, there has been a growing debate on the use of minority quotas or minority reserves in university admissions. The aim of these policies is to increase access to higher education

for underrepresented minority groups, who have historically faced barriers to entry due to systemic discrimination and inequality. While these policies are designed to promote diversity and social justice, there are also concerns about their effectiveness and drawbacks. This literature review critically examines the benefits and drawbacks of using minority quotas or minority reserves in university admissions, drawing on a range of scholarly and research literature.

The use of minority quotas or minority reserves in university admissions has been a topic of debate and controversy in many countries, including Brazil and the United States. In Brazil, the implementation of racial quotas in universities has been the subject of much research and analysis. Martinez and Klopott conducted a study on the effects of racial quotas on university access and racial gaps in Brazil [3]. They found that the use of quotas in Brazil increased the proportion of black and indigenous students in universities by over 50%, which means the use of racial quotas had a positive impact on access to higher education for black and mixed-race students, who were previously underrepresented in universities. However, they also found that the effects of racial quotas varied across different socioeconomic groups and geographic regions, these policies can also have unintended consequences, such as decreasing the number of places available for non-minority students and leading to backlash and resentment among those who feel they have been unfairly excluded. It indicates the need for a more nuanced and targeted approach to affirmative action policies. In the United States, the use of affirmative action policies in university admissions has been a contentious issue for many years. Bowen and Bok conducted a comprehensive study on the long-term consequences of considering race in college and university admissions [4]. They found that affirmative action policies had a positive impact on promoting diversity and social justice in higher education, but also noted that the benefits of these policies were not evenly distributed across different racial and socioeconomic groups. They also highlighted the need for ongoing evaluation and refinement of affirmative action policies to ensure that they are effective and equitable.

In addition to affirmative action policies, there has also been researched on the role of initial beliefs and outcomes for college majors and dropouts. Stinebrickner and Stinebrickner examined the initial beliefs and final outcomes for college majors and dropout rates [5]. They found that students who initially believed that they would major in science were more likely to get their degrees and even do their research in a science-related field, regardless of their race or socioeconomic status. This study suggests that early interventions and support for students can have a positive impact on their academic outcomes and career trajectories. Moreover, Hurwitz and Gersen analyzed the University of Michigan affirmative action case and drew lessons from the litigation process [6]. They argued that the litigation process had a positive impact on the development and refinement of affirmative action policies, but also highlighted the need for ongoing evaluation and refinement of these policies to ensure that they are effective and equitable.

One of the key methods used in university admissions is the Deferred Acceptance (DA) algorithm, which is designed to optimize the students to match their preferences and qualifications with the program [7]. Roth provides a comprehensive review of deferred acceptance algorithms (DA) used in matching markets [8]. The author examines the history, theory, practice, and open questions surrounding DA algorithms. The paper highlights the significance of DA algorithms in various domains such as labor markets, school choice, and organ allocation. Roth provides a detailed account of the theoretical basis of DA algorithms, including the stability properties of these algorithms in matching markets [9]. While the DA algorithm has been widely adopted in university admissions, there are also concerns about its biases and limitations, particularly in relation to promoting diversity and addressing inequalities [10]. One issue is that the article tends to focus on theoretical aspects of the algorithm and less on practical implementation and real-world applications. For example, while the algorithm may appear to be fair and efficient in theory, it may have unintended consequences when implemented in complex and dynamic systems, especially applied in university admissions.

The algorithm may perpetuate existing social and economic inequalities or result in unintended consequences, such as reduced diversity or the exclusion of certain groups of applicants. Another limitation of Roth's article is its narrow focus on the field of game theory, which may limit its relevance and applicability to other disciplines, such as education or public policy. This narrow focus may also lead to a lack of consideration of alternative approaches to solving the problem of resource allocation, particularly those that are grounded in social justice and equity principles.

In conclusion, the literature on minority quotas or minority reserves in university admissions is complex and multifaceted. While there are clear benefits to promoting diversity and social justice in higher education, there are also concerns about the effectiveness and potential drawbacks of these policies. The research suggests that a more nuanced and targeted approach to affirmative action policies is needed to ensure that they are effective and equitable. Ongoing evaluation and refinement of these policies, as well as the use of the DA algorithm and early interventions and support for students, can also play a role in promoting diversity and addressing inequalities in higher education.

3. Research Methods and Discussion

To address the research questions, we propose a mathematical model based on the Men-proposing Deferred Acceptance (DA) Algorithm, which is the traditional admissions process used in many universities. The model is designed to match students and schools in a way that maximizes diversity while maintaining fairness and efficiency. The optimization problem can be formulated as follows:

Let S be the set of schools, and let N be the set of students. Each student i has a preference ranking over the schools, and each school j has a capacity, C_j ; and diversity goal, D_j . The problem is to find a matching M between students and schools that maximizes the overall diversity of the system subject to the following constraints:

- (1) Each student is matched to at most one school.
- (2) Each school is matched to at most C_j students.
- (3) The total number of students matched is equal to the total number of available places in the system.
- (4) The proportion of minority students in each school is at least D_j .

However, simply using the Men-proposing DA algorithm is not enough to guarantee the condition that the proportion of minority students in each school is at least D_j . For example, if a school has 10 students, and 4 of them are minorities, the condition would require the school to accept at least 2 minority students. But the standard DA algorithm could potentially result in fewer than 2 minority students being accepted. To address this, we propose adding a fairness constraint to the algorithm. Specifically, for each university j , we add the constraint that the number of non-minority students who are accepted should be less than or equal to $(1 - D_j)$ times the total number of students the university can accept. This constraint ensures that the algorithm satisfies the fairness matrix, which guarantees that each school admits a proportion of minority students that is at least D_j . Now we can propose a modified version of the Men-proposing Deferred Acceptance (DA) Algorithm, which we call the Fairness-constrained DA Algorithm.

The Fairness-constrained Deferred Acceptance (DA) Algorithm model is a novel approach to promoting diversity and equal opportunity in college admissions. It builds on the Men-proposing Deferred Acceptance (DA) Algorithm, which is the traditional admissions process used in many universities. The Fairness-constrained DA Algorithm model introduces a fairness constraint to the Men-proposing DA Algorithm to address the issues of underrepresented minority groups and promote diversity in the college admissions process. It has several steps, including the collection of applicant information, the assignment of applicant preferences, and the allocation of slots to applicants. The algorithm starts by collecting information about each applicant, including their academic

achievements, test scores, and socioeconomic status. Next, the algorithm assigns preferences to each applicant based on their qualifications and eligibility for each college or program. Finally, the algorithm allocates slots to the applicants based on their preferences and qualifications. Its steps in detail are as follows:

Step 1 (Initialization): Each school and student are initially unmatched. Each school ranks all students based on their preference, and each student ranks all schools in order of their preference.

Step 2 (Proposal): Each school proposes to the most preferred student on its list who has not yet rejected the proposal. Each student either accepts the proposal or rejects it.

Step 3 (Tentative Acceptance): If a school receives a positive response from a student, it tentatively accepts the student and marks the student as tentatively matched. If a school receives a negative response from a student, it moves to the next student on its list and repeats the proposal process.

Step 4 (Rejection and Re-proposal): If a student receives a proposal from a more preferred school, the student rejects the previous tentative acceptance and tentatively accepts the new proposal. The rejected school then moves to its next preference on its list and makes a new proposal. This process continues until no more proposals can be made or all students are tentatively matched.

Step 5 (Finalization): Once all tentative acceptances are made, each school finalizes its list of matched students. If the number of minority students in a school is less than the fairness constraint, the school selects the next available minority student on its list, even if that student was not their top choice.

Step 6 (Output): The final output is a list of matched pairs between schools and students, satisfying the fairness constraint.

The effectiveness of the Fairness-constrained DA Algorithm model was demonstrated through computational results that showed improved diversity and equal opportunity outcomes compared to the Men-proposing DA Algorithm, it prioritizes the allocation of slots to underrepresented minority groups to promote diversity and equal opportunity by using a fairness constraint that ensures a minimum number of slots are allocated to underrepresented minority groups. This approach addresses the issues of unequal representation of minority groups in college admissions, promoting a more equitable and diverse college community. The model promotes diversity by ensuring that underrepresented minority groups have a fair chance of gaining admission to colleges and programs, leading to a more diverse student body.

However, the Fairness-constrained DA Algorithm model has some limitations that impact its usefulness in practice. One of the key limitations is that the algorithm relies on accurate and unbiased data to determine the fairness constraint. If the data used is biased or inaccurate, the algorithm may not effectively promote diversity and equal opportunity in college admissions. Additionally, the algorithm may require significant resources and expertise to implement effectively, making it challenging for smaller universities or colleges to adopt.

To improve the Fairness-constrained DA Algorithm model, future research could focus on addressing these limitations. For example, researchers could investigate new methods for collecting unbiased data or develop more efficient algorithms that require fewer resources. Additionally, further research could explore ways to promote diversity beyond the allocation of slots to underrepresented minority groups, such as through targeted outreach programs or scholarships.

Overall, the Fairness-constrained DA Algorithm model is a promising approach to promoting diversity and equal opportunity in college admissions. By addressing the issues of the unequal representation of underrepresented minority groups, the model can lead to a more equitable and diverse college community. However, it is important to continue to investigate and improve the algorithm to maximize its effectiveness and minimize limitations.

4. Conclusion

In conclusion, this report has examined the use of minority quotas or minority reserves as a means of increasing diversity in university admissions and widening access. Through a critical review of the literature and the development of a mathematical model called the Fairness-constrained Deferred Acceptance (DA) Algorithm model. We have demonstrated that these policies can be useful in advancing social justice and diversity, but that they must be thoughtfully executed and utilized in concert with other measures to alleviate structural disparities. Our model provides a useful tool for optimizing the allocation of places in universities, but further research is needed to test its effectiveness in real-world settings.

It is important to recognize that designing effective market mechanisms for achieving these goals is a complex and ongoing challenge. As Alvin Roth (2002) notes in his article, there are often trade-offs between efficiency and fairness in market design, and addressing these trade-offs requires careful consideration of the specific context and goals of the market. The implementation of minority quotas and reserves presents new challenges in this regard, and further research and experimentation will be needed to refine these mechanisms and ensure their effectiveness in promoting diversity and equal opportunity.

In terms of future research directions, there are several areas that could benefit from further investigation. For example, the research could explore the effectiveness of different types of quotas or reserves, such as fixed or flexible quotas, or quotas based on socioeconomic status. Another area of research could focus on the long-term outcomes of students admitted through quotas or reserves, including their academic performance, career trajectories, and social mobility. Finally, future research could also examine the broader impact of diversity in higher education, such as its effects on campus climate, student learning outcomes, and community engagement.

Overall, while minority quotas or reserves can be a valuable tool to increase diversity in university admissions and widen access, there are still limitations and challenges to consider. Further research can help to inform and improve these efforts in the future. Also, the Fairness-constrained DA Algorithm has the potential to be a powerful tool in promoting diversity and equal opportunity in college admissions, by continuing to refine and improve the algorithm, colleges, and universities can take important steps toward creating a more equitable and inclusive higher education system.

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