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Student Behaviors in College Admissions: A Survey of Agent-Based Models

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Abstract

The process of selecting colleges and securing admissions is influenced by numerous elements, particularly academic performance, behavioral tendencies, and equity considerations. Academic metrics such as high school grades and standardized exam results often form the cornerstone of admission criteria. However, behavioral factors, including decision-making styles, personal motivations, and self-image, play an equally critical role in shaping students' application choices. For instance, while some students may aspire to enroll in elite universities, others, constrained by financial limitations or self-imposed doubts, might opt for less competitive institutions. Social influences, access to advisory resources like school counselors, and awareness of the admissions process further shape students' choices and behaviors. Students from underserved or marginalized communities often face additional hurdles, leading them to prioritize institutions based on proximity, affordability, or program flexibility that aligns with their unique needs. This paper explores agent-based modeling techniques adopted by international universities to study secondary education pathways and student behaviors in the context of admissions. By examining these models, the research highlights how they simulate complex decision-making processes and systemic interactions to foster equitable practices in university admissions. Emphasizing behavioral dimensions, these models underscore the importance of creating fairer systems that address the diverse needs and aspirations of students while promoting inclusivity and justice in higher education.

Keywords : Agent-Based Model, ABM, Agents, Behavior, Education, Equality, Simulation, Survey

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1. INTRODUCTION

Universities around the world compete to attract students, but the quality of education varies greatly between institutions. Factors such as teaching quality, faculty experience, campus environment, and the use of advanced technologies all contribute to these differences. To stay competitive, schools must adopt smart technologies that improve both education quality and the overall student experience [3]

Students' emotions and behaviors play a significant role in their college decision-making process. The pressure to choose the "right" college can cause stress and anxiety, while fear of failure or making a wrong choice may lead to indecision or hesitation [4] Peer influence and family expectations can add to this emotional burden, pushing students toward choices that may not align with their personal goals or strengths. Additionally, some students struggle with self-doubt, believing they are not good enough for competitive institutions, while others may be overly influenced by a school's reputation rather than considering their own needs and preferences. Behavioral tendencies, such as procrastination or over-reliance on external opinions, can also impact how students navigate the admissions process. These challenges are even more pronounced for disadvantaged students, who may experience heightened stress due to financial constraints, limited access to guidance, or systemic barriers. Such factors can lead to misaligned choices or missed opportunities, with some students ultimately transferring schools, resulting in financial and academic setbacks.

Agent-based simulation models provide valuable insights into these complexities by incorporating academic, social, emotional, and behavioral factors. These models replicate realworld scenarios, examining how students' emotions and decision-making behaviors interact with systemic influences. Research [16], [15], [8], [13], [1] demonstrates that these models can help universities develop more equitable and effective admissions practices, ensuring that students' emotional and behavioral challenges are better addressed in the process

Despite the availability of numerous simulation models and studies focusing on education, technology, business, and other fields [10], [14] there is a noticeable gap in research addressing the behavioral aspects of students in university admissions. While agent-based models (ABM) have been applied to simulate various complex systems, only a limited number of studies emphasize understanding and improving students' behaviors and decision-making processes during college admissions. The objective of this paper is to review recent studies utilizing agent-based models to simulate university students' admission behaviors, highlighting the need for deeper exploration of emotional, cognitive, and social factors that influence these critical decisions.

1- How does ABM help simulate the decision-making process of students when choosing a university, including the role of their behaviors and emotions?
2- In what ways does ABM influence parental behavior when selecting the most suitable universities for their children?
3- How can ABM be used to simulate various scenarios for allocating university seats to high school students during the admission process, considering student behaviors and preferences?

2. RELATED WORKS

This article reviews recent high-impact studies focusing on agent-based modeling (ABM) in educational contexts, particularly in simulating university admission processes. By analyzing cutting-edge research, we aim to highlight trends, challenges, and opportunities in this field.

2.1 Exploring Student Decision-Making and Behavior

Recent studies emphasize the complexity of students' choices during college admissions. For instance, [5] examined selection mechanisms and the role of behavioral tendencies in college choice using structural empirical methods. Similarly, [20] applied ABM to simulate how social and economic factors influence the sorting process in higher education. These studies reveal how ABM can capture students' cognitive biases, emotional responses, and socioeconomic constraints in decision-making.

2.2 Socioeconomic and Environmental Influences

ABM has also been employed to explore broader socioeconomic and environmental impacts on education. [6] investigated how income inequality and educational attainment interact with global environmental challenges. Their findings highlight the role of ABM in understanding the interplay between individual behavior and systemic factors in educational attainment.

2.3 Simulating Admission Policies and Seat Allocation

Several studies focus on the effectiveness of admission policies through ABM. [7] simulated school choice scenarios with information asymmetries, uncovering key insights into how policy changes impact equity and student satisfaction. [9] used real-time simulations to examine the coordination of college admissions, shedding light on strategies for optimizing seat allocation. Moreover, [2] used an Agent Based model (ABM) to simulate different scenarios by using Netlogo software (v. 6.3). The authors used different parameters such as the family-income and the high school GPA in order to maximize the utilities of the fairness and equalities of universities admission, after several rotations of the simulation the reputation of medical schools are identified based on students’ preferences and seats’ allocated as it shows that high ranking universities are mainly allocated with have high cutoff GPA score.

2.4 Broader Applications of ABM in Education

Beyond admissions, ABM has proven valuable in related areas like teacher training and eLearning. [13] explored ABM’s role in implementing mobile learning among student teachers, while [15] demonstrated its accessibility as a tool for field-based educational research. On the other hand, [11] applied ABM by using details of SAT scores and core courses of the Department of Physics and Astronomy at a large public university, the prime focus of the paper is to model the impact of the system, which, in reality, helps to save time and cost.

3. RESULTS

3.1 Insights from Reviewed Studies on ABM in University Admissions

The reviewed studies reveal the diverse applications of agent-based modeling (ABM) in simulating student admissions, focusing on different perspectives and case studies. These insights are summarized below:

1. Deferring University Admissions

Bhatia et al. (2015) explored the dynamics of deferring admissions in higher education. Using NetLogo, they modeled prospective students' decision-making processes, highlighting how individual choices and institutional policies interact to influence enrollment trends.

2. College Allocation and Student Welfare

[5] examined the relationship between college allocation mechanisms and student welfare. By analyzing the interplay between community-level dynamics and individual choices, this study underscored how allocation policies affect student satisfaction and equity.

3. School Choice Under Information Asymmetries

Focusing on Santiago, Chile, [7] applied ABM to simulate K-12 school choices in a community context. Their findings revealed how information asymmetries between students and schools could lead to suboptimal outcomes, emphasizing the need for transparent policies.

4. Enhancing Fairness in Admission Systems

In Inner Mongolia, [9] employed ABM to design a more equitable admission system for colleges. Their simulations demonstrated how fairness in allocation could be improved, particularly for underrepresented and disadvantaged student groups.

5. Behavioral Influence on College Sorting

[20] focused on how students' attributes and behaviors affect the sorting of colleges. By simulating community-level dynamics, their study illuminated the influence of individual traits on institutional stratification.

6. Affirmative Action in Admissions

A follow-up study by [20] investigated the role of affirmative action policies in university admissions. Their analysis provided valuable insights into how such policies impact enrollment diversity and equity.

7. Educational Attainment

Using ABM to model educational choices in Italian neighborhoods, [12] explained the persistent issue of low educational attainment. The study shed light on how societal and familial factors influence junior and senior high school students' decisions.

4. REVIEW ANALYSIS

4.1 Educational Attainment

4.1.1 The Role of ABM in Understanding Student Behavior in Higher Education Decisions

Educational attainment involves students deciding whether to pursue higher education after high school. This decision is influenced by various factors, including personal aspirations, peer influence, and social environments. Research shows that students' behavior during this decisionmaking process is shaped by their surroundings and the expectations set by their social connections [6]

[12] investigated the behavioral factors influencing students' college choices in Italy using an agent-based model (ABM). This study emphasized the importance of the social environment, modeling neighborhoods where students interact with family, friends, and peers. These interactions play a critical role in shaping individual choices about higher education. For example, Junior agents (high school graduates) observe the educational and career outcomes of Senior agents (working adults) within their social network. If Senior agents with higher education credentials achieve better outcomes, this positively influences Junior agents' likelihood of enrolling in college.

Leoni's simulation, built using the NetLogo platform, explored scenarios where students made decisions based on three primary factors: future income expectations**,** peer influence**,** and personal effort to earn a degree**.** The model revealed that peer influence was a significant determinant of student behavior, as Juniors were more likely to enroll in college if they observed peers with similar socioeconomic backgrounds succeeding academically. Interestingly, the results indicated that students from families with a history of higher education (e.g., parents with bachelor's degrees) were more likely to enroll, highlighting the intergenerational impact of education on student behavior.

[5] further explored students' behavioral responses to changes in college admissions systems. Their ABM examined how altering school capacities or exempting entry exam fees influenced student choices and welfare. The findings suggested that students are highly adaptive, adjusting their applications based on perceived opportunities, such as increased school quotas or reduced barriers to entry. This demonstrated that policy interventions could directly shape student behavior, encouraging higher enrollment rates when structural obstacles are removed.

4.2 K-12 education system

4.2.1 How the ABM Affect the Parents' Behaviors in Selecting the Right Schools for Their Children?

The role of students and parents' behavior in selecting schools has become a significant area of research, particularly with regard to how educational models can influence decisionmaking processes. Agent-based models (ABM) are an effective tool for exploring these behaviors, particularly in the context of K-12 education. ABMs can simulate how students interact with schools, with different environmental attributes (such as family income, school location, and school performance) shaping students' school selection behaviors. These models help to understand how students and parents make choices based on various factors to maximize their utility. [7] used NetLogo 6.0.4 as the development environment for their ABM simulation, where agents representing students and schools interact. The model considered multiple factors influencing the school selection process, including family income**,** school rankings**,** location**,** and the type of school (public vs. private). Additionally, the model simulated students' behaviors by introducing random environmental attributes to reflect the variability in real-life decision-making scenarios.

The model's results demonstrate that high-income students tend to enroll in higher-ranked schools, which are often private institutions, leading to higher academic outcomes such as improved GPAs. This behavior is influenced by both the students' desire for a high-quality education and their parents' preferences for schools that promise better future outcomes. Furthermore, the model reveals that student behavior is also shaped by social factors—students often follow the educational paths of their peers or family members who have successfully navigated the educational system, particularly in families where higher education is valued.

By exploring different scenarios through the model, such as varying school rankings and tuition fees, the ABM illustrates how students' selection behavior aligns with both their family's financial capacity and their academic ambitions. Moreover, this research emphasizes the strategic decisions students make based on what will maximize their educational and future career opportunities, showing a clear connection between socioeconomic status and school choice behavior.

Ultimately, the ABM not only sheds light on how parents influence the selection of schools for their children but also highlights the pivotal role students play in these decisions. Students' aspirations, academic performance, and peer interactions all contribute to shaping the final decision, ensuring that the chosen school aligns with their long-term educational and personal goals.

4.3 Universities Admissions & Students Preferences

4.3.1 What is the Role of the ABM in Simulating Different Scenarios for Allocating the Available Seats for High School Students During the Admission Process?

[19] used an Agent-Based Model (ABM) to simulate the college admissions process, focusing on understanding how family resources impact students' college choices and acceptance outcomes. The model captures how students' behaviors influence the sorting process and allocation of available seats in colleges. In this simulation, students make decisions based on a variety of internal and external factors, including academic performance, socioeconomic status, and their understanding of how different universities operate. The model proceeds in three stages: the applications stage, the admission stage, and the enrollment stage**,** where students behave as agents making decisions at each stage based on their personal attributes and external influences.

Student behavior is shaped by numerous factors such as family income**,** academic ability**,** college preferences**,** and financial aid needs**.** For instance, students from wealthier families may apply to more selective schools, knowing they can afford the associated costs or that they will receive substantial financial aid. Conversely, lower-income students may prioritize colleges with more affordable tuition or those that provide more generous financial support. Students' risk tolerance also plays a significant role in their decision-making. Some students might choose to apply to highly competitive schools despite low chances of acceptance, driven by ambition or the desire for social status, while others might strategically choose less competitive institutions to ensure a higher likelihood of acceptance.

In a similar approach, Bhatia et al. (2015) used an ABM in NetLogo to simulate the allocation of available seats during the college admissions process. Here, universities and students are modeled as agents with their own decision-making processes. In the partially centralized admissions scenario, each university sets its own cutoff scores, and students make choices based on these thresholds. The fully centralized admissions scenario, on the other hand, places the responsibility for allocating seats on a central authority after high school results are released. In both scenarios, the model reflects how students modify their behavior based on their understanding of admission policies and cutoff marks. Some students may apply to less competitive universities even if their grades would allow them entry into more prestigious schools, driven by a desire for certainty or a preference for specific programs. Others may be overconfident in their abilities and apply only to the most competitive institutions, ignoring the risk of rejection.

An additional layer of student behavior emerges in the manipulation behavior model developed by [9] In this scenario, students can coordinate with one another to exploit gaps in the admission system. For example, high-scoring students may apply to universities that accept lower scores, thus securing a spot and "releasing" a seat for lower-scoring students who would otherwise not have a chance. This strategic behavior reflects the collaborative decisionmaking that can occur in high-stakes environments where students aim to maximize their chances of admission. This manipulation behavior often occurs close to application deadlines when students have a better sense of which universities have available seats and which ones are still accepting applications.

Moreover, students' preferences are highly variable and often influenced by peer behavior, social trends, and marketing efforts by universities. For instance, students might be more likely to apply to universities that have visible social media presence or strong alumni networks. Their decisions are also affected by a desire for social prestige, leading some students to apply to Ivy League schools or other top-ranked universities despite the financial and academic challenges that come with such institutions.

In the case of affirmative action policies, [20] observed that students from underrepresented racial or ethnic groups, including Black, Hispanic, and Asian students, may adjust their behavior to capitalize on these policies. The students may prioritize universities that have more favorable affirmative action policies, believing that these policies improve their chances of admission. This adaptive behavior demonstrates the students' ability to strategically navigate the complex admissions system, highlighting how policy changes directly influence students' college selection behaviors. Students may also modify their applications based on their perceived likelihood of acceptance, diversity goals, and available support systems at different universities.

5. CONCLUSION

Student behavior is shaped by a variety of factors, both academic and non-academic, that significantly influence their college selection and admission decisions. While academic factors like GPA**,** SAT scores**,** AP courses, and extracurricular activities often dominate the conversation, socioeconomic influences also play a critical role. Students' family income and access to financial resources can shape their perceptions of college affordability, their likelihood of applying to certain institutions, and their choices regarding financial aid and scholarships. This inequality in resources can introduce biases into the admission process, affecting not just the choices students make, but also the fairness of the seat allocation in the admission mechanism.

The various simulations reviewed highlight that these behaviors are not static; they evolve depending on the context**,** cultural norms**,** and admission policies of different regions and institutions. Countries with centralized admission systems (like in China) exhibit different behavioral patterns from those with more decentralized or individualized systems (like in the United States), where students may have more flexibility and strategic control over their applications. Moreover, policies such as affirmative action introduce new behavioral dynamics, where students from disadvantaged backgrounds might adjust their applications based on perceived opportunities to benefit from such policies.

Different simulation approaches, whether using agent-based tools like NetLogo or statistical methods, all point to the complexity of student decision-making. Rather than passively following institutional guidelines, students actively weigh various academic, social, and personal factors, adapting their choices in response to new information or changing circumstances.

Understanding these behaviors requires more than just analyzing academic records or socioeconomic status. A deeper focus on psychological and social influences can lead to admissions systems that are not only fairer and more transparent but also better aligned with the realities of how students navigate their options

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