Machine Learning and Medical Appointment Scheduling: Creating and Perpetuating Inequalities in Access to Health Care

See also Morabia, p. 421, and Rodenberg, p. 441.

We are deeply concerned about how machine learning and algorithms create and perpetuate inequalities in health. We are to believe that algorithms are developed to ensure that no one will have an unfair advantage over anyone else and that human bias is removed from decision-making. Sounds good in theory.

In real-life circumstances—such as medical diagnoses and policies that determine access to health care and social services or where your child is placed in school—algorithms can separate populations into groups of haves and have-nots along racial lines, exacerbating the racial disparity experienced by the different groups. Algorithms can determine the health of entire communities. Invisible to most of us, algorithms are described as the great equalizers.

However, unlike people, all algorithms are not created equal. Scheduling a medical appointment is the most common way for patients to access a health provider: a patient asks for an appointment and is given a day and time to see a doctor. If she's on time, she expects that she'll be seen at or about the time of her appointment. Straightforward and fair? Or not? Our recent study[1] argues that state-of-the-art appointment scheduling algorithms may, in fact, contribute to racial disparities, because they make Black patients wait longer than non-Black patients.

In our study, in which we examined electronic scheduling systems in safety net clinics, we revealed how racial bias is woven into the algorithms of electronic health records scheduling systems. To understand how this happens, consider how modern appointment scheduling systems work. To maximize efficiency, most outpatient clinics overbook some of their appointment slots, that is, they give the same appointment time to more than one patient. Overbooking is meant to ensure that providers are fully utilized even if some patients fail to show up for their scheduled appointment. However, if patients who are scheduled in overbooked slots do show up, some of them will experience waiting time at the clinic because the provider can see only one patient at a time.

Modern appointment scheduling systems decide which patients to overbook through machine learning: when a patient is given an appointment, a machine-learning algorithm predicts his or her individual probability of showing up for the appointment at the scheduled time—the show-up probability. It can be shown that to maximize efficiency, a clinic should overbook the patients with the lowest show-up probability. Although the purpose is to optimize provider time and clinic revenue, unfortunately, these same algorithms overbook Black patients, forcing them to wait longer. Built into machine learning, apparently, is that for Black patients, timely, quality care can wait.

Significant amounts of data factor into the calculation of a patient's show-up probability: sociodemographic information, the patient's past no-shows, the number of past appointments, how far in advance the appointment is scheduled, and so on. Critically, it is well known that lower show-up probabilities are correlated with factors typically associated with less advantaged socioeconomic status: limited transportation, lack of health insurance, and inconsistent employment, to name a few. In this safety net clinic, Black patients are overrepresented at the lower socioeconomic status level.

Some studies show that Black patients are less likely to show up; other studies show that the patients that are least likely to show up should be overbooked; we connected the dots.

We were honored to work with coauthors Shannon Harris of Virginia Commonwealth University and Haibing Lu and Michael Santoro of Santa Clara University on "Overbooked and Overlooked: Machine Learning and Racial Bias in Medical Appointment Scheduling,"[1] in which we revealed how racial bias is woven into the algorithms of electronic health records scheduling systems. Our concern is that patients least able to afford waiting are forced to wait longer to be seen by providers and that these patients may in fact leave before being seen, perhaps never to return until their health conditions have worsened. Black patients are overbooked, not because they're Black but because of the lived experiences of being Black and having a low income. However, their failure to show up for appointments can

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be conflated with race and incorporated into algorithms in the name of efficiency.

Our study developed a solution method to address racial disparity by modifying the objective of the scheduling algorithm. Essentially, instead of optimizing the in-clinic waiting time of the general patient population, our method optimizes the in-clinic waiting time of the group that is worse off. This way, we remove disparities between the different groups. When tested on the data set of a large specialty clinic whose Black patients have a lower show-up probability than non-Black patients, our proposed solution method can build schedules without any racial disparity and without any negative impact on clinic efficiency.

In other words, we showed that it is possible to achieve efficiency without adversely affecting patients. More importantly, it is possible to factor the experiences of a disadvantaged population into algorithms in a way that promotes equity.

Our study suggests that there are ways that machine learning and optimization can be used for the benefit of all patients, without leaving anyone behind. AJPH

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The authors contributed equally to this editorial.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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Howard Rodenberg Comments

See also Morabia, p. 421, and Samorani and Blount, p. 440.

No one of good faith can dispute that lack of access to care is a significant problem or that health disparities plague minority and marginalized populations. In their article, Samorani and Blount (p. 440) ably suggest how algorithm-based safety net clinic scheduling appointment programs may negatively affect in-clinic waiting times and access to care.[1] But their conclusion that embedded within these programs is the idea that "for Black patients, timely, quality care can wait" and that "racial bias is woven into the algorithms" is language that obscures the specific challenges posed by artificial intelligence (AI) systems.

An AI system does not in and of itself reflect any moral view. As the authors note, in the context of clinic scheduling the system will simply look at the demographics of who shows up for appointments and who does not and, based on its review, will determine a probability. In broad terms, if your no-show rate is 50% or higher in a population, it makes sense to double-book patients in that population, as the chances are that at least one patient will show up and the time slot will not go unused. Research has illustrated that the probability of being a no-show is often linked to lower socioeconomic status, and undoubtedly minority and marginalized populations are overrepresented in this group.[2–4] Assuming these trends in the literature reflect the larger world, an AI algorithm will simply respond to the demographics in its captive population.

Samorani and Blount's contentions are also hampered by the lack of a clear impact. If further study reveals that prolonged in-clinic waiting times associated with AI scheduling systems significantly affect care, then there's evidence for change. But for now, proof of impact remains unknown.

The authors present their own solution to eliminate racial disparities in waiting times by modifying scheduling algorithms to minimize the in-clinic waiting time of the group expected to wait the longest. Testing in a clinic data set indicated that this model may improve wait time disparities with no impact on clinic efficiency.

But are there better ways to address patient scheduling to decrease waiting times and minimize disparities in access to care? We might redirect scheduling algorithms to identify factors in minority and marginalized populations associated with improved clinic attendance. These data might then be used to preferentially schedule specific clients or to identify specific community issues (such as transportation), which may be amenable to focused intervention. We might also employ means such as reminder calls to ensure that scheduled appointments are not forgotten.

Perhaps we'd do better by considering an entirely new scheduling paradigm, one that both minimizes disparities in access to care and improves clinic performance. The same day scheduling scheme ("open-access scheduling"), whereby no patients are scheduled in advance and are instead seen on the day they call for an appointment, has been shown to result in shorter waiting times, lower no-show rates, improved patient satisfaction, and higher provider productivity[5,6] (https://bit.ly/2SDj5JE; https://bit.ly/2tekf5m). Success may also be found with programs in which patients are seen on either the day of the call or the following day (same day or next day) to allow them time to arrange services such as transportation and child care. Although it's true that no matter what scheduling plan is chosen socioeconomic factors may influence access to care, using a system that minimizes the role of demographics in scheduling appointments seems ideal.

Samorani and Blount have admirably "connected the dots"

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