Algorithm-Based Advertising: Unintended Effects and the Tricky Business of Mitigating Adverse Outcomes

Anja Lambrecht and Catherine Tucker

THE AUTHORS

Anja Lambrecht
Professor of Marketing, London Business School, England
alambrecht@london.edu

Catherine Tucker
Professor of Marketing, Massachusetts Institute of Technology, Cambridge, MA, USA
cetucker@mit.edu

Algorithms are everywhere ✕ In the digital age, algorithms are often praised as powerful tools that help people and organizations make better decisions and accomplish their objectives more effectively. It is typically assumed that they function purely fact-based and would produce unbiased and objective outcomes. However, there is more and more evidence that algorithms might lead to outcomes that resemble the discriminatory tendencies of humans. For example, Amazon had to cancel plans for the implementation of an AI-driven automated recruiting tool because the system turned out to favor male over female applicants. Apple's algorithms associated with their newly launched credit cards in 2019 sparked an enquiry. The system had offered men much higher credit limits than women, even if they were married, sharing all their bank accounts.

Biases in automated advertising ✕ Biased algorithms can also be observed in advertising. In an eye-opening study, computer science professor Latanya Sweeney investigated the role of race in Google ads. She searched for common African-American names and recorded the ads that appeared with the results. She then searched for names that are more common among whites. The searches for black-sounding names were more likely to generate ads offering to investigate possible arrest records. Apart from racial discrimination, other findings also document gender biases. In our own study related to online advertising, we investigated such effects in the context of STEM (science, technology, engineering, and mathematics) careers. We sought to understand how Internet and social media algorithms determine whether advertising content gets seen more by men or women and why. Our results suggest that advertising algorithms are not gender-biased as such, but economic forces that govern them might lead to unintended uneven outcomes.
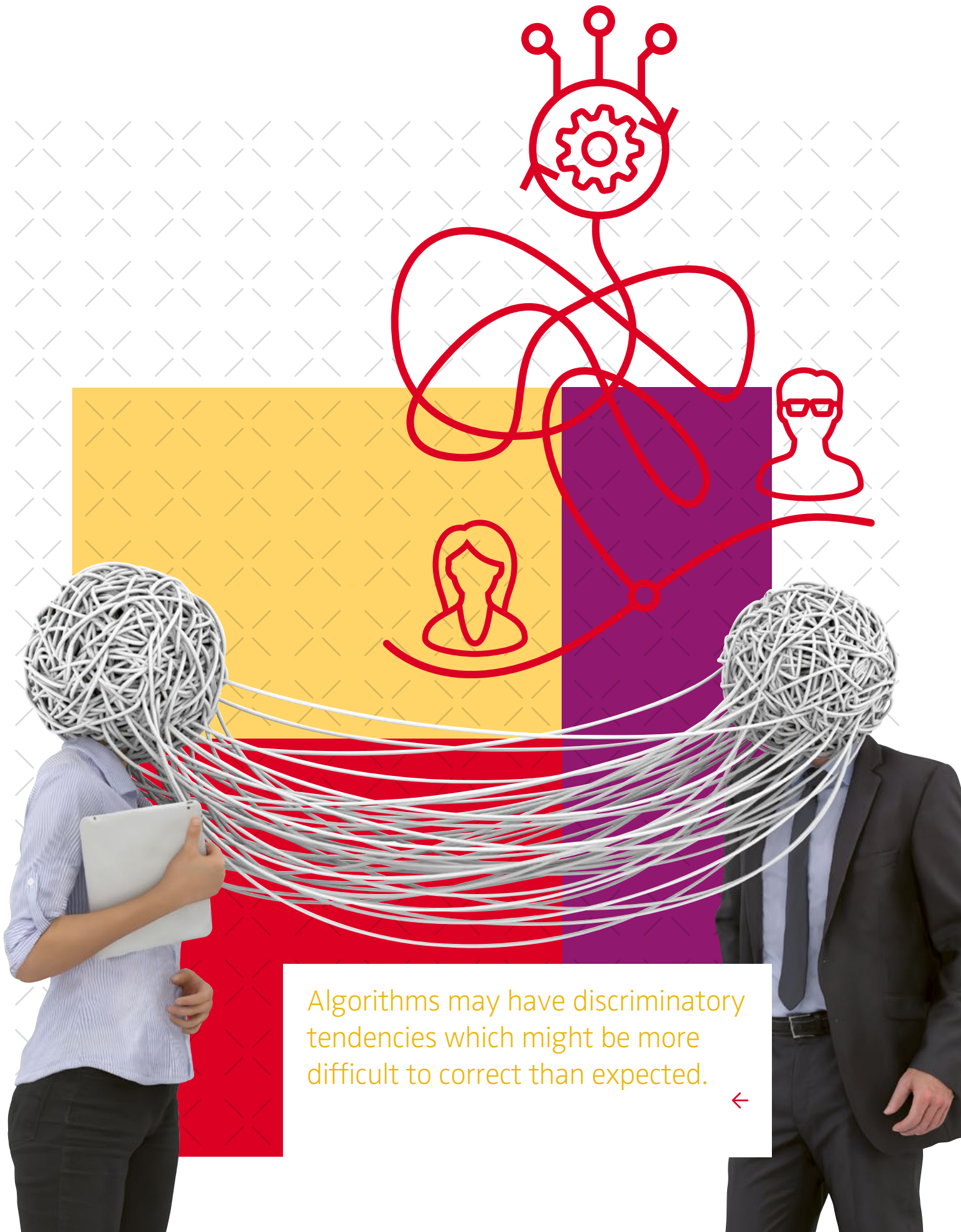
Algorithms may have discriminatory tendencies which might be more difficult to correct than expected.

BOX 1

Researching the effect of algorithms on the science gender gap

There is a chronic shortage of graduates going into science or engineering (STEM) around the world. That shortage is even more acute among women. In the US, only one in seven engineers is female, while in the UK, that number drops to a meager 6% of the STEM workforce. This shortage is concerning both to policy makers as well as companies.

One theory that we explored is that part of the problem can lie in how information about STEM opportunities is disseminated among women in the first place and whether it is similarly easy to reach men and women with ads for STEM careers. In our field study using Facebook ads we sent messages about STEM careers to a cross-section of men and women aged between 18 and 65 in 191 countries. The ad was intentionally not targeted toward a specific demographic group of consumers (see Figure 1).

FIGURE 1 › Example of STEM ad and the used ad-targeting settings in each country

STEM careers – information about STEM careers
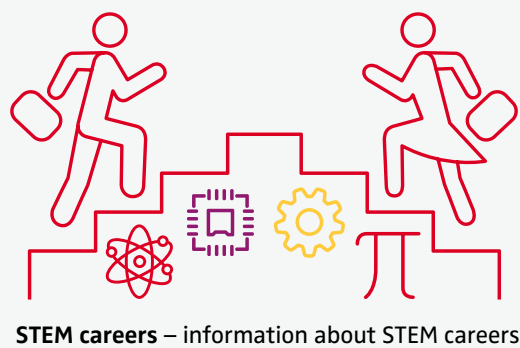
Location	People who live in this location		
	United States		
Age	**18 +**		
Gender	**All**	Men	Women

We then analyzed the data reported by Facebook for advertisers. We found that across all advertising campaigns:

> **20% more men than women saw the ad.**
> **In particular, women aged 25–34 were 40% less likely to see the STEM ad than their male counterparts of the same age.**

Examining possible explanations ⌗ The fact that women were so much less likely to see the ad was surprising, as no characteristic of the campaign had specified such an imbalance. Therefore, we investigated possible reasons.

The first question was whether the algorithm might have learned its behavior from women simply not clicking on ads as much as men. If that were the case, the advertising algorithm may have concluded that it was more economical to show ads to men. However, it turned out that women tended to click more often than men. Thus, that could not be the reason for the uneven display of ads.

Second, we asked whether the algorithm might have faced some sort of capacity constraint in that insufficient female eyeballs were available to see ads. However, women are similarly active to men on social media.

Third, we examined whether possibly the algorithm was reflecting underlying patterns of discrimination against women in specific countries. However, data from the World Bank revealed no relationship between the educational and labor market opportunities for women and whether STEM ads were displayed to them in the study.
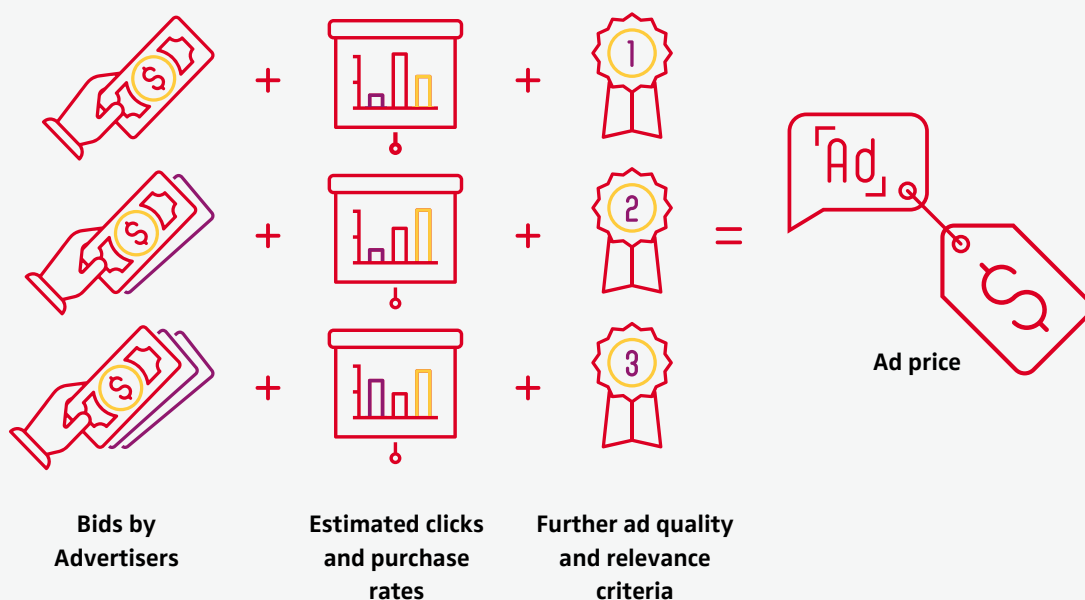
BOX 2

Advertising auctions on Facebook and other platforms

On Facebook's online advertising platform – similar to other online advertising platforms – different advertisers compete with each other to get their content in front of the same set of eyeballs by placing "bids." They specify the amount of money they are willing to pay if their ad is displayed to a user and the user clicks on it. When a user loads a page, Facebook then runs an instantaneous real-time auction in the background to determine which ad gets shown, using ad quality and relevance and estimated action to determine the price (see Figure 2).

Advertisers who want to make sure that they are very likely to show the ad to a specifically targeted user need to specify higher bids. If advertisers have high expectations that displaying their ads will convince users to buy their products, they are more likely to bid highly for this specific user or segment of users. At the same time, this advertiser might not even advertise to consumers who are unlikely to make purchases. As a result, the price for displaying an ad can vary strongly across different consumers or segments of consumers.

Many reports confirm that women are more likely to click on an ad and make a purchase, which holds for a large variety of goods, including tech products. Research suggests that women drive as much as 90% of all consumer purchasing. Therefore, displaying ads to women is more expensive than displaying ads to men. Looking at Facebook's recommendations to advertisers on which bids to make across different gender and age segments, it turns out that indeed, for targeting women, higher bids are recommended: On average, the advertising platform suggests that advertisers bid $0.05 more to advertise to women than men.

FIGURE 2 > How automated real-time auctions on Facebook and other platforms work

| Bids by Advertisers | Estimated clicks and purchase rates | Further ad quality and relevance criteria | | Ad price |

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Last, we turned to explore whether underlying economic mechanisms might be causing the imbalance in the display of STEM ads across genders, and we found an explanation in the way advertising auctions on Facebook and other platforms work (see Box 2).

Economic mechanisms: The actions of other advertisers interfere ⨯ The implication of higher bids by competing advertisers is that when advertising indiscriminately across genders, such as was the case in the campaign for STEM careers, advertisers are more likely to get their ads in front of males than in front of females. The algorithm does not intend to discriminate, but spillover effects across different industries mean that they are more likely to reach one segment of the population than another. The higher price for female views

results from the higher likelihood of women, especially those aged 25 to 34, to convert each view of an advertisement into an actual purchase. This means that for an advertiser with a gender-neutral strategy, it is more difficult to reach women. Economic forces might unintentionally favor men.

Mitigating insidious algorithms is tricky ⨯ Finding solutions to this kind of problem is challenging for two reasons. First, the issue is caused by the unintended interaction between different independent economic participants who each have their own advertising strategies. Second, employment laws in most countries do not yet adequately stipulate how targeted advertising fits within existing discrimination frameworks. Some seemingly simple solutions might not work properly.
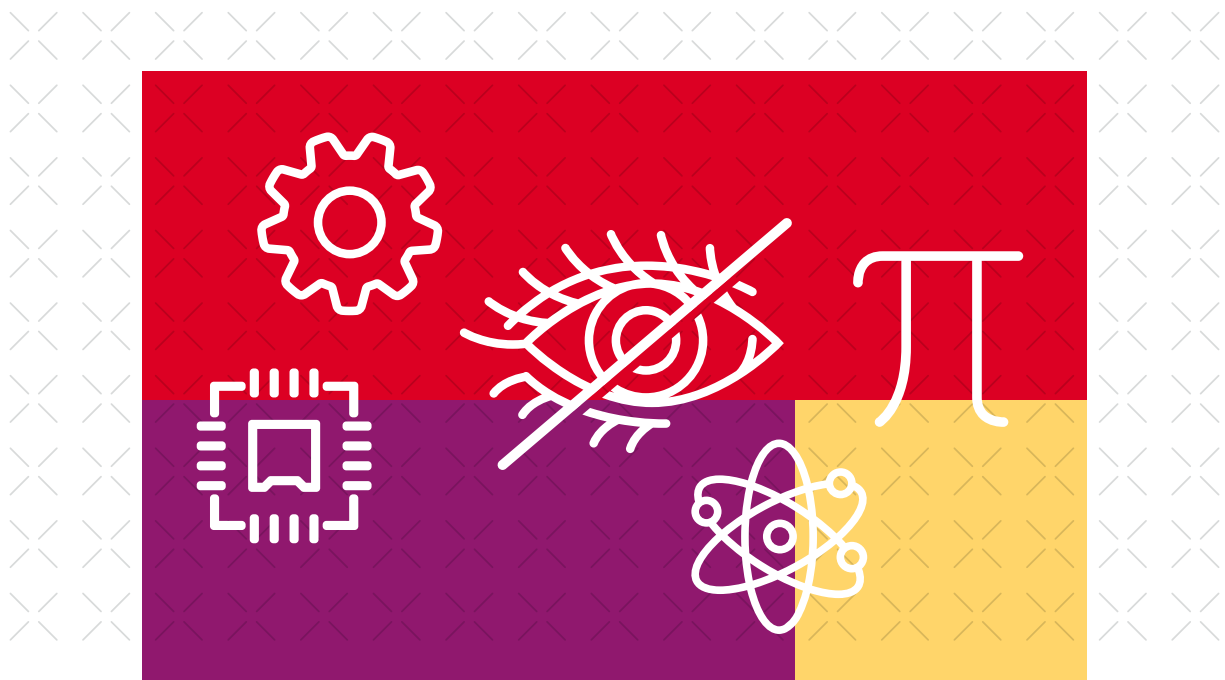
› **Separate campaigns?** ✕ At first sight, one potential solution could be for advertisers to run separate campaigns for men and women to make sure they can reach both demographic groups equally. We set up a campaign that would do exactly this. However, Facebook prevented us from even running this campaign. The reason was that in the US, federal law prevents companies from targeting employment ads to only one gender. So ironically, a law that was designed to avoid discrimination actually ruled out a fairly simple way to correct the bias and made it harder for advertisers to fix unintentional uneven outcomes.

› **Transparency?** ✕ Another popular approach to preventing apparent instances of discrimination has been to focus on algorithmic transparency, whereby algorithmic codes are made public. Transparency might be helpful to counteract discrimination if it is hard-coded into an algorithm. However, in the particular context of our STEM campaign, algorithmic transparency would not have helped regulators to foresee uneven outcomes. It would likely have revealed an algorithm focused on minimizing ad costs for advertisers, which is reasonable. Without appropriate knowledge about the economic context and how such cost minimization might affect the distribution of advertising, such ''transparency'' would not have been particularly helpful.

› **Equal advertising distribution across groups?** ✕ Therefore, algorithmic transparency and gender neutrality will not suffice in addressing unequal gender outcomes. The highlighted tension illustrates the further need for policy guidance in this area. One potential solution is for platforms to offer advertisers the option for a specific campaign of distributing ads equally across specified demographic groups.

Policy makers should be watchful ✕ These results should be concerning to policy makers and platforms, as disseminating information can be important to ensure equal opportunities for access. The key allocation mechanism that dictates the distribution of information does not reflect the desirability of information dissemination; instead, it is the return on investment of advertising across all industry sectors. Advertising allocation decisions by a retail sector selling household products may affect communication opportunities and costs in the sector offering job opportunities. Groups that policymakers may worry about not receiving the same information – in our study, women, compared to men – might be more costly to engage.   ✕

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FURTHER READING

Lambrecht, A.; & Tucker, C. (2019): ''Algorithmic Bias? An Empirical Study of Apparent Gender-Based Discrimination in the Display of STEM Career Ads'', Management Science, Vol. 65(7), 2966-2981. https://doi.org/10.1287/mnsc.2018.3093

Sweeney, L. (2013): ''Discrimination in online ad delivery'', ACM Queue, Vol. 11(3), 10:10–10:29.