DISSERTATION PROPOSAL

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“Artificial Intelligence/Machine Learning Economics: Transparency, Competition, and Collusion”

Friday, December 3, 2021
1:00pm EST
Via Zoom

Machine learning (ML) algorithms are being increasingly applied to decision-making processes with far-reaching impacts extending to employment, access to credit, and education. While ML algorithms have shown great predictive power in various business applications, there are rising questions about the economic and social consequences of algorithmic decision-making, and increasing calls for algorithmic transparency. In my dissertation, I study three key aspects that arise with use of ML algorithms in economic systems: transparency, competition, and collusion.

In Chapter 1, I examine the economic implications of algorithmic transparency in a hiring context. Specifically, I answer the following research question: Should firms that apply machine learning algorithms in their decision-making make their algorithms transparent to the users they affect? Despite the growing calls for algorithmic transparency, most firms have kept their algorithms opaque, citing potential gaming by users that may negatively affect the algorithm's predictive power. I develop an analytical model to compare firm and user surplus with and without algorithmic transparency in the presence of strategic users. I identify a broad set of conditions under which making the algorithm transparent actually benefits the firm. By contrast, users may not always be better off under algorithmic transparency. These results hold even when the predictive power of the opaque algorithm comes largely from correlational features and the cost for users to improve them is minimal. These results suggest that firms should not always view manipulation by users as bad. Rather, they should use algorithmic transparency as a lever to motivate users to invest in more desirable features.

In Chapter 2, I theoretically investigate how firms strategically reveal information about their decision-making algorithms to users in a competitive market. ML algorithms are widely used by financial lenders in their screening processes. Almost all such algorithms are hidden from the consumers who are affected by their decisions. As a result, financial intermediaries, such as Credit Karma, have emerged who provide personalized “odds of approval” for a financial product to a consumer by reverse engineering a lender's screening algorithm. Lenders can reduce consumer uncertainty by sharing their algorithm with the intermediary allowing it to provide accurate ``odds of approval'' and benefit from market expansion without a threat of gaming by consumers. However, only a few lenders reveal their screening algorithms to intermediaries. I find that competitive pressures between lenders can reduce the disclosure incentives, and that asymmetric sharing of algorithms by symmetric lenders is an equilibrium outcome. Lenders use asymmetric revealing of algorithms strategically to soften the competition when their algorithms are fairly accurate. The asymmetric sharing of algorithm endogenously creates product differentiation and allows lenders to focus on different segments of consumers. In addition, policies that mandates all lenders to provide personalized ``odds of approval'' to consumers freely may not necessarily improve consumer surplus.

In Chapter 3, I study how platforms design choices can mitigate collusion by reinforcement learning based pricing algorithms. As many sellers on online platform are adopting pricing algorithms, there are increasing concerns that the algorithms may learn to collude and raise prices to supra competitive levels. In this chapter, I will first theoretically study the case where two sellers who sell horizontally differentiated products use reinforcement learning algorithms to set prices automatically on a platform, and identify conditions, in terms of the nature of the products sold on the market and the features of the platform such as recommender systems and ranking algorithms being used, under which such reinforcement learning algorithms may converge to collusive strategies in repeated interactions even without explicit communication. I will then demonstrate the results using numerical simulations and then collaborate with a real-world e-commerce platform to test it in the field.