Clearing matching markets efficiently: informative signals and match recommendations

In many two-sided marketplaces agents search to form matches with potential partners based on mutual compatibility. Examples include labor markets, online dating, college admissions, and accommodation. Forming matches often requires extensive and costly communication between participants and their potential partners. For instance, on a large global freelancing platform, fewer than 10% of job applications get a response, and yet over half of job openings remain unfilled, including when the employer invites individual freelancers. A major challenge for such marketplaces is to ease such congestion, but without reducing the choice available to participants. In this paper we explore, in a stylized setting, how matching markets can be efficiently cleared by encouraging informative signaling between users and providing participants with good match recommendations.

To study congestion in two-sided matching markets, we adopt the classic notion of stability introduced by Gale and Shapley (1962); in a stable matching, no pair of agents would both prefer to match with each other over their assigned partners. This captures a key feature of such markets, which is that agents cannot simply choose their partner. Stability has been adopted as an equilibrium notion to capture real world outcomes. Moreover, platforms that seek to implement stable outcomes can prevent agents from looking for matches elsewhere, for instance on other platforms.

Many marketplaces use centralized clearinghouses that implement stable matchings in order to ease congestion including the National Residency Matching Program and several school/college admission systems. In these centralized marketplaces, participants on both sides of the market submit preferences, which are then converted into a stable matching using the deferred acceptance (DA) algorithm. But even in these centralized platforms, participants may be unable to list their true preferences over all potential partners. For example in the NRMP, medical students are only permitted to rank hospitals they have interviewed with and the logistical costs of interviews limits the length of the ranking.
Learning and communicating preferences may be even harder in many online or decentralized marketplaces. We use the amount of communication between participants as a (stylized) measure of the congestion in a marketplace. We ask: “How can we help the market to arrive at a stable (market clearing) outcome with only a small amount of communication?” Recent theoretical results suggest that it may indeed be difficult for large markets to arrive at stable matchings. Using the theory of communication complexity, which studies the minimum communication required to accomplish certain tasks from an information theory perspective, Segal (2007) proves that for any method of finding stable matchings, there exists a distribution of preferences in which agents must learn and communicate their preferences for a substantial fraction of the entire market. More precisely, the worst-case amount of communication needed per agent grows linearly with the number of agents, i.e., in worst case each agent needs to communicate almost her entire preference list over the other side. This communication requirement is implausibly large for many real markets, which have many thousands of agents on each side, suggesting that there is an inevitable tension between providing choice to market participants (as captured by stability) and reducing market congestion.

In this paper, we show that under natural assumptions on the distribution of preferences and prior knowledge of agents (or the matching platform), stable matchings can be reached via only limited communication (much less than linear in market size per agent) even in large markets, if agents participate in informative signaling. By “informative” we mean that certain signals are more useful than others in helping the market converge to a stable matching. The idea of our communication protocols is to employ signals that help agents estimate whom they can realistically be matched with, and to encourage agents to reach out to easier-to-get partners, while waiting for harder-to-get partners to reach out to them. We show that when every agent participates in such signaling, the market can, with high probability, reach a stable matching with low levels of communication and preference
learning effort. Moreover, in typical markets, it is in the best interest of each agent (i.e., incentive compatible) to comply with such a signaling scheme, assuming that others also do so.

The structure of signaling employed by our protocol is compatible with features of real world matching marketplaces, including online platforms. For instance, in the online labor market Upwork, freelancers apply to jobs, but an employer may also “signal” by inviting a suitable freelancer to apply, and Upwork facilitates such signaling by recommending freelancers to employers who have posted a job. Further, Upwork guides freelancers by recommending suitable jobs. The structure of our communication protocols provides (stylized) guidance on how a matching platform like Upwork can enable efficient clearing of the market by encouraging informative signaling and providing appropriate match recommendations to market participants.