Dynamic Matching with Post-allocation Service and its Application to Refugee Resettlement

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Motivated by our collaboration with a major refugee resettlement agency in the U.S., we study a dynamic matching problem where each new arrival (a refugee case) must be matched immediately and irrevocably to one of the static resources (a location with a fixed annual quota). In addition to consuming the static resource, each case requires *post-allocation* services from a server, such as a translator. Given the uncertainty in service time, a server may not be available at a given time, thus we refer to it as a *dynamic resource*. Upon matching, the case will wait to avail service in a first-come-first-serve manner. Bursty matching to a location may result in undesirable congestion at its corresponding server. Consequently, the central planner (the agency) faces a dynamic matching problem with an objective that combines the matching reward (captured by pair-specific employment outcomes) with the cost for congestion for dynamic resources and over-allocation for the static ones. Motivated by the observed fluctuations in the composition of refugee pools across the years, we aim to design algorithms that do not rely on distributional knowledge. We develop learning-based algorithms that are asymptotically optimal in certain regimes, easy to interpret, and computationally fast. Our design is based on learning the dual variables of the underlying optimization problem; however, the main challenge lies in the time-varying nature of the dual variables associated with dynamic resources. Our theoretical development brings together techniques from Lyapunov analysis, adversarial online learning, and stochastic optimization. On the application side, when tested on real data from our partner agency, our method outperforms existing ones making it a viable candidate for replacing the current practice upon experimentation.

Link to the full version of the paper: https://ssrn.com/abstract=4748762