Research Statement*

Nawaaz Khalfan†

Department of Economics, Univsersity of Pennsylvania

Strategic Search and Exploration

Understanding the search for and allocation of resources is essential for answering many important social questions. When we look at models of search in order to gain insight into economic decisions and outcomes, we often encounter the following issues:

1. they treat the options being searched as exogenous,
2. they don't consider multiple agents conducting the search, and
3. they are solved with techniques that can obfuscate properties of optimal search behaviour.

The work I have done, and continue to do with my research agenda, addresses these issues by incorporating concepts of agency and competition in models of search, and studying the resulting outcomes. In order to achieve this, I've developed tools to derive and analyse optima in these environments and have outlined how these environments map to many important applied topics in economics.

1. Optimal Allocation with Noisy Inspection

In many settings, the information that is being discovered by the searcher is privately held by the option they are searching. In canonical models of search, the option has no agency and thus no ability to report this information. On the other extreme, in the mechanism design literature the option - an *agent* - has perfect information about the searchers value and so the act of inspection involves only a single verification of the agent's report. In this context, my paper "Optimal Allocation with Noisy Inspection" explores the value of inspection as a tool for discovery and verification.

In a standard principal-agent allocation model, I endow the agent with a noisy private signal about the principal's return and allow the principal to inspect the return at a cost. The inspection and allocation mechanism that maximizes the principal's expected return without the use of transfers then describes optimal inspection as both an exploration and a screening tool. This optimal mechanism is simple, inspecting high types and allocating if a sufficient reward is discovered, and partially allocating to low types without inspection. This relates to a number of applied settings such as employer hiring strategies, public grant mechanisms and portfolio investment rules.

*Compiled in preparation for the 2022/2023 Academic Job Market.

†email: khalfan@sas.upenn.edu; website: www.nawaazkhalfan.com

2. Strategic Private Exploration

In sequential search, the reason for exploring a particular option early may not only account for the time and resource costs of search, but also the risk of losing that option to a rival searcher. I study these strategic considerations in "Strategic Private Exploration" where exploration is the setting where searchers are allowed to keep all options they explore.

In a strategic exploration game, multiple players determine the order in which they explore unknown options with the objective of maximizing the sum of discovered rewards. Exploration is private in the sense that players cannot condition the order in which they explore on their competitor's decisions. I determine symmetric equilibrium exploration procedures in this environment, and characterize losses as a function of how the rewards are split when simultaneously explored. This informs us about many areas of policy design including patent and copyright regimes, research and development tournaments, and competition regulation.

3. Pandora's Linear Program

Most models of search are solved via dynamic programming, which while productive, makes the solution difficult to generalize to nearby environments. In joint work with Rakesh Vohra, we map Weitzman's canonical search problem into a linear program, allowing us to re-derive existing results and discover new characteristics of optimal search behaviour. This allows us to extend the setup to problems pertaining to strategic search, information acquisition, index manipulation and robust search.

Future work

The techniques and methods used in the development of these projects are very general and can be extended to many outstanding questions in the social sciences. Immediately, while "Optimal Allocation with Noisy Inspection" concerns noise on the agent's signal, the same analysis can be applied to noise on the inspection technology, providing analysis to a model of *noisy verification*.

Furthermore, a question of significant interest in the field is the analysis of *sequential testing* with flexible choice of inspection technology. While sequential information acquisition can be tricky to characterize, recent contributions in the literature and the analysis in "Pandora's Linear Program" makes this project much more attainable. In the other direction, generalizing to multiple agents is also of immediate interest given this research agenda, providing analysis to a true model of *noisy search*. This would allow for a full comparison to the results in the mechanism design and search literature. This is difficult to characterize due to the combinatorial nature of scheduling problems, but made more accessible by the work in "Pandora's Linear Program".

Finally, extending the applications in "Pandora's Linear Program", particularly *manipulation-robust search procedures* and *strategic private search*, could generate new results and many interesting applications of strategic search and exploration.

Updated: November 4, 2022