Strategic Search and Exploration

Research Statement*

Nawaaz Khalfan†

Department of Economics, Univsersity of Pennsylvania

When we look at models of search (and exploration) in order to gain insight into economic decisions and outcomes, we often encounter the following barriers:

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 current research agenda, seeks to address these barriers by incorporating concepts of agency and competition in models of discovery, 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 applied topics in economics. Examples of this can be found in the following research papers.

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 often has perfect information about the searchers value and so the act of search involves only a single verification. In this context, my paper "Optimal Allocation with Noisy Inspection" explores the value of inspection as a tool for both 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 relates to a number of applied settings such as employer hiring strategies, public grant mechanisms and portfolio investment rules.

2. Strategic Private Exploration

In sequential search, the reason for selecting a particular option early does not necessarily come from the cost of the search in terms of time or resources, but the risk of losing that option to a rival searcher. I study these strategic considerations in "Strategic Private Exploration" where exploration

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

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 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[1] we map Weitzman's canonical search problem into a linear program, allowing us to re-derive existing results and emphasize new characteristics of 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 derivation of these projects are very general and can be extended to many outstanding questions in the literature. 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, that is, a model of *noisy verification*.

Furthermore, a question of significant interest in the literature is the analysis of *sequential testing* with flexible choice of inspection technology. While sequential information acquisition models can be tricky to characterize, recent contributions in the literature and the analysis in "Pandora's Linear Program" make this project far more attainable.

Generalizing "Optimal Allocation with Noisy Inspection' to multiple agents is also of immediate interest given this research agenda, being 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 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 and is a research project that I'm pursuing.

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[1] University of Pennsylvania, rvohra@seas.upenn.edu