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Modeling Directed Local Search on a Technology Landscape

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It has long been argued (in different contexts: Evenson & Kisley 1976, Hey 1982, Levinthal & March 1981, Nelson & Winter 1982, Telser 1982) to be appropriate to model technological change as a random (and mainly local) search within a population of possibilities. Indeed, from the one hand, empirical observations show that most of the new techniques come as a result of recombination of previously known components, rather than discovery of new ones, while from the other, that most of the technological advance is an incremental process.With the coming of the computer age, a number of simulation techniques have been devised to model technological search within complex environments of interconnected systems and Kauffman's NK model (Kauffman & Levin 1987, Kauffman 1993) became one of the most commonly used frameworks.Despite the great advantaged of that framework, however, its being designed for the domain of evolution on microbiological level brings in a number of drawbacks when applied to the issue of how the firms search for new technologies. One of the main such drawbacks, the implied lack of purportive action from the agents conducting the search, is the main issue of the current investigation.While the assumption of local search presupposes that only one element of the system can be changed at a time, there is no reason to assume in sequel that the decision on how to direct the search has to be made randomly. A common assumption made in this group of models is that the state of a randomly chosen element is being flipped, and the resulting efficiency compared to the one of the currently possessed technology. Different scenarios of that comparison have been devised; it may be the case that just the efficiency of the flipped element is of importance, or rather the average efficiency of some group of elements, or, more commonly, the overall efficiency of the whole system. Whichever is the case, all those scenarios fail short to answer two important questions: (1) why was it exactly that particular element whose state was flipped at a given time, and (2) why do we assume the agents to be so extremely myopic to be able to judge only on the basis of comparison between just two adjacent periods? Moreover, still keeping the assumption of search being local in nature, we can argue that (3) there is nothing that prevents the agents to consider several options, or directions of search, at a time.Strangely enough, probably one of the key strengths the NK model framework provides us with, has been consistently overlooked. That strength is the implied ability to model and compare the agents possessing different levels of rationality or foresight. On the structural level, the current model brings into the picture two new control parameters: breadth and depth of search. Breadth of search is a horizontal measure of how many options for a change the agents are able to consider at each level and at each given step. Depth of search is a vertical measure of the maximum number of periods ahead that the agent has foresight into at each given step. Thus stated the model is deducible both to the original NK model of local search where depth=breadth=1, as well as the models of perfect foresight where depth=breadth=N.It is obvious to claim that higher depth/breadth combinations would lead to better outcomes, other things held constant, and in the extreme case of perfect foresight with maximum breadth of search, the agents are guaranteed to find the global optimum for any presumed complexity of the landscape. However, such exhaustive search is very hard computationally, and hence, is not consistent with the notion of bounded rationality and computational skills. It is much more interesting to observe that even for very complex landscapes perfect foresight is by far not a necessary condition for finding the global maximum. There exists, nevertheless, a positive correlation between the level of complexity (interconnectedness) of the landscape and the necessary breadth/depth combination to be employed to guarantee the achievement of the optimal efficiency level. This means, that determining the correlation structure of the landscape for a given technology is a very important task for a firm, because while wanting to keep the costs of search down firms would be inclined to choose smaller breadth/depth combinations, such combination has still to be chosen that guarantees it either optimal (for the case of maximizing agents) or sufficiently good (for the case of satisficing agents) result.

Referente

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