Chapter 10
Innovations and Organizational Structures

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ABSTRACT

This chapter presents a novel model to represent the relative results that different innovation strategies can be expected to attain in respect of technological spaces defined by different complexity levels. The model representing complexity is based on Kauffman's fitness landscape (known, also, as NK fitness landscape). However, contrary to the original proposal, we used a functional and deterministic representation of complexity defined over a real-valued space, replacing a stochastic and statistical-based definition of complexity in binary-valued spaces. The search strategies proposed are inspired to hierarchical organizations like companies. Low-level employees are assumed to have a full (technical) knowledge of a sub-set of the organization's functions, but lack the global vision necessary to assess the impact of a change on the overall organization's performance. Higher-level management has the task to weight different alternative proposals and select the best one for the benefit of the company as a whole, even though they are not able to explore directly technical solutions. The results confirm the results already known in the literature, though in much clearer and robust way, and suggest a large number of possible extensions.

1 INTRODUCTION

Collective decisions, as those made by organizations, require coordination in order to avoid that well-intentioned moves, directed to improve some aspects of the organization's performance, harm the very same performance because of un-intended side-effects.

Ideally, decision makers should be able to predict any consequence, positive and negative, for any available move. However, in practice this is impossible because the complexity of the environment and the myopia of actors, resulting in adopting pragmatic heuristic to assess whether a given change should be adopted or not.

This chapter proposes a general framework to assess the validity of different types of heuristics in respect of different types of environmental complexity. The model for complexity proposed is based on

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the widely adopted Kauffman's *Fitness Landscape* (FL)[1]. In contrast to the latter, the model representing complexity proposed here allows for greater control by users, such as imposing a specific and deterministic shape to the fitness landscape. The proposed model also allows for weighted interdependency links determining the level of complexity, besides the very number of the links as allowed by the original model. The modified model retains the same properties as the original model, greatly extending the possible uses and the possibility of analysis of results. In particular, we analyse the consequences of different types of modular complexity, ie the complexity stemming from the interactions among groups of variables. Past works have already determined the properties of these systems, that we replicate to support the compatibility of the novel representation proposed.

A model for complexity is useful because you can compare the performance generated by different exploration strategies, that is, algorithm by which a simulated agent explores the space in search of highest fitness. We propose a strategy modelled on the governance structure of hierarchical organizations, such as companies. We consider that lower level members of the organizations have in-depth knowledge of a (narrow) set of functions that they control. This allows the members at this lower (technical) level to assess the validity of all possible alternatives available, performing what is normally referred to as *off-line* exploration. That is, they review all possible alternatives for the set of functions under their control selecting what appears as the most attractive, following a given evaluation criterion. The problem with these research activities is that these agents have little knowledge of potential changes to the functions outside their remit; consequently, they need to assume (possibly incorrectly) that the rest of the modules of the company will not change, and on this assumption they perform their evaluations.

The upper level of the organization (the *management*) lacks the expertise and/or resources to monitor this search. The activity of the management consists in deciding which, if any, of the changes proposed by the lower level should be actually implemented. Contrary to the lower level, the management cannot test different alternatives change, but only decide irreversibly which change to implement, on the basis of (possibly inaccurate) performance-improving expectations associated to each change. In other terms, management is forced to proceed with *on-line* exploration, implementing one of the proposals from the technical level without knowing its actual performance.

The paper analyses several implementations for the problem space (i.e. different levels of complexity) and of organizational structures in order to derive results in terms of performance that may be expected. The rest of the paper is organized as follows. The next section describes the model for complexity used in this paper, which is a totally novel implementation of the overall concept of complexity proposed by Kauffman and widely adopted in management literature, known as the Fitness Landscape (FL) model. The novel model simplifies the representation of the most relevant features of the model, and also extends its flexibility in ways that, we sustain, are particularly relevant for the management literature. This model for complexity will be used as the problem that agents (in the form of organizations) will have to solve, that is, identify a path from an point of the problem space randomly chosen up to the highest possible performance.

Next, we describe the representation of the governance structure adopted. It relies on a streamlined representation of a hierarchical organization, where the division of labor between lower level workers and higher level management is clearly represented. The model allows for alternative implementation of the activities at the two levels of the hierarchy, allowing for the exploration of different types of organizational structure.

The last section before concluding presents the results produced with the help of simulation exercises. We investigate the performance reached by different types of organizational structures when applied to