

Talent on Task: Core Decisions and Agents

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Abstract

Almost fifty years ago Herbert A. Simon, Allen Newell and J.C. Shaw produced the Logic Theorist, a procedural program capable of solving a modest range of problems in formal symbolic logic (Psychological Review, 65: 151-66, 1958). The research strategy was novel and direct: pose a problem and build a symbolic agent capable of solving the problem.

A few years later, Richard M. Cyert, James G. March and others adapted this strategy to model price and output determination in a business firm (A behavioral Theory of the Firm, Prentice-Hall, 1963).

In the intervening years the strategy has been utilized by many researchers in many domains including laboratory puzzles, games, language acquisition, physics, chemistry, and resource allocation processes in public and private organizations. Some of this work is grounded in the careful study of subjects solving the posed problems. Other work is grounded more in the researchers' introspections on how they would solve the problem. Some of the work, especially the organizational work, is very abstract with no clear empirical referents. Other work never gets around to building the agents; once the problem is sharply posed, why fiddle around trying to understand how lesser mortals might work the problem when you can move directly to developing powerful heuristic solutions, perhaps even optimal solutions?

For understanding the behavior of individuals and organizations, the strategy has much to recommend it. Simon's original interest, for example, was in the bounds on rational behavior. Such bounds become very clear with the discipline of building an explicit model that must acquire and process information to achieve a particular result.

The purpose of the work reported here is to model agents performing an organizational task common to virtually all organizations that produce goods and services. A large portion of the initial effort is devoted to developing a computer-based architecture that will permit rich experimentation with agents and context.

The Task

The task and its importance is easily seen in the old story about the difference between heaven and hell.

St. Peter asked a new arrival whether he wanted to go to heaven or hell.

The new arrival asked, "what's the difference?"

St. Peter responded, "Well it's really not as great as some people believe. The difference mainly turns on who does what:"

"In heaven, the English are the police; the French are the cooks; the Germans are the mechanics; the Italians are the lovers; and the Swiss are the administrators.

In hell, the English are the cooks; the Germans are the police; the French are the mechanics; the Italians are the administrators; and the Swiss are the lovers."

All organizations that produce goods and services have a core technology – the processes by which they transform inputs to outputs. The success of an organization's technology, however success might be defined, depends to some extent on the way in which the business is chunked into tasks and people are assigned to those tasks. The people vary in skill and motivation. The tasks vary in the skills required to perform them.

Managers in education organizations assign faculty to classes and to non-teaching roles. Managers in manufacturing organizations assign employees to roles in supervision, design, assembly, testing and quality control, shipping and receiving, maintenance, etc. Managers in restaurants assign employees to hostess, wait tables, bus tables, cook, and cashier.

This managerial assignment task is important, ubiquitous and inescapable.

The human capital is heterogeneous with respect to the requirements. There are very capable cooks who would fail as waiters or cashiers. Exceptional skill in design or assembly may not signify supervisory ability. Great teachers or researchers may not make great academic administrators. Most physicists should not be assigned to teach writing and most writers should not be assigned to teach physics.

For the omniscient manager in any business, the assignment task is not very difficult. With perfect knowledge of both the employees' capabilities and production requirements, the omniscient manager can do the assignment so as to optimize on a criterion such as cost per unit of output.

Unfortunately, there are no omniscient managers in real producing organizations. Knowledge of employees' capabilities and production requirements is imperfect.

In real time in real organizations, managers must learn about capabilities and requirements by observing performance.

We posit a simple producing organization, a sales organization, and to model the sales manager as a decision agent solving the assignment problem.

The sales task we posit for this exploratory exercise is simplistic in several respects. It is stationary and deterministic. The sales territories and number of employees are fixed. There are no interdependencies in production. Experimentation is costless. There is a knowable optimum assignment.

The sales manager has unfettered access to everything that management scientists, economists, and statisticians know. Her memory is perfect. She must, however, learn about capabilities and requirements from accumulated direct experience.

With all of the above simplifications and more, it is astounding how difficult this assignment problem is. It is very hard for a boundedly rational agent to find the optimum and even harder to recognize the optimum when the possibility space has not been fully explored. When the simplifying assumptions are relaxed so that sales are stochastic and non-stationary or sales are done by two or three person teams rather than individuals, the assignment problem becomes much more difficult.

The Agents, The Context and Simulation Overview

We explore a variety of agents in terms of what they observe, what they remember, what they believe a priori about the salespersons and territories, and how they use the information. Two baseline agents, the omniscient manager and the amnesiac manager, are implemented.

Sales territories and salespeople are modeled as bit vectors (Figure 1). In the case of a territory representation, each element in the vector represents a truth-value as to whether or not a particular territory requires a threshold level of skill in a given aspect of sales performance. In the case of a salesperson representation, each vector element represents a truth-value as to whether or not a particular salesperson possesses a threshold level of skill in a given aspect of sales performance. Our initial model assumes that skill thresholds for task attributes are identical across all assignment options and that territory attributes are as well. These bit vectors make it relatively easy to compare and contrast salespeople and territories on the basis of the skill elements that distinguish them.

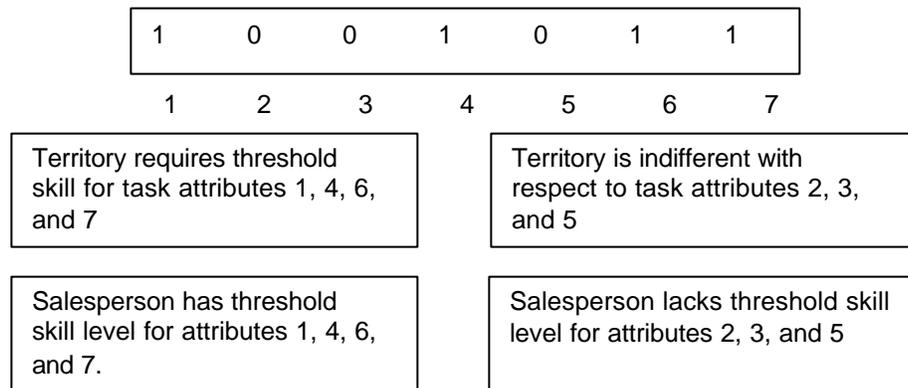


Figure 1. Sales territory / salesperson skill representation

In our experiments we are able to generate random virtual salespeople and territories using user input parameters regarding what percentage of the known skill set are possessed or demanded respectively. Other parameters applied are the seeding of the worker population with perfectly skilled members and completely demanding territories (i.e. $\langle 1, 1, 1, \dots, 1 \rangle$) and weaker salespeople and territories that entail very few of the skills possible.

This initial design is meant to be flexible and easy to extend with additional strategies and representational modifications. Figure 2 shows the overall flow of a simulation that provides data for hypothesis testing. All experiments are conducted in Monte Carlo fashion and mean results are used for the generation of observations. For each experiment, no matter what strategy is selected, the best possible score obtainable using that experiment's set of salespeople and sales territories is computed, and the entire space of assignment configurations captured. The entire space of assignments is of size $n!/(n \cdot m)!$ where n is the number of territories and m is the number of salespeople with $n \cdot m$. We include this costly step at price of limiting the size of these initial experiments in order to support discussion and comparison of mental models that the various classes of decision-making strategy used actually entail.

The architecture permits a rich set of experiments with contextual factors as well as defined agents. The factors of interest include the performance regime for managers, competitors in the sales territories, and the supply of replacement salespeople.

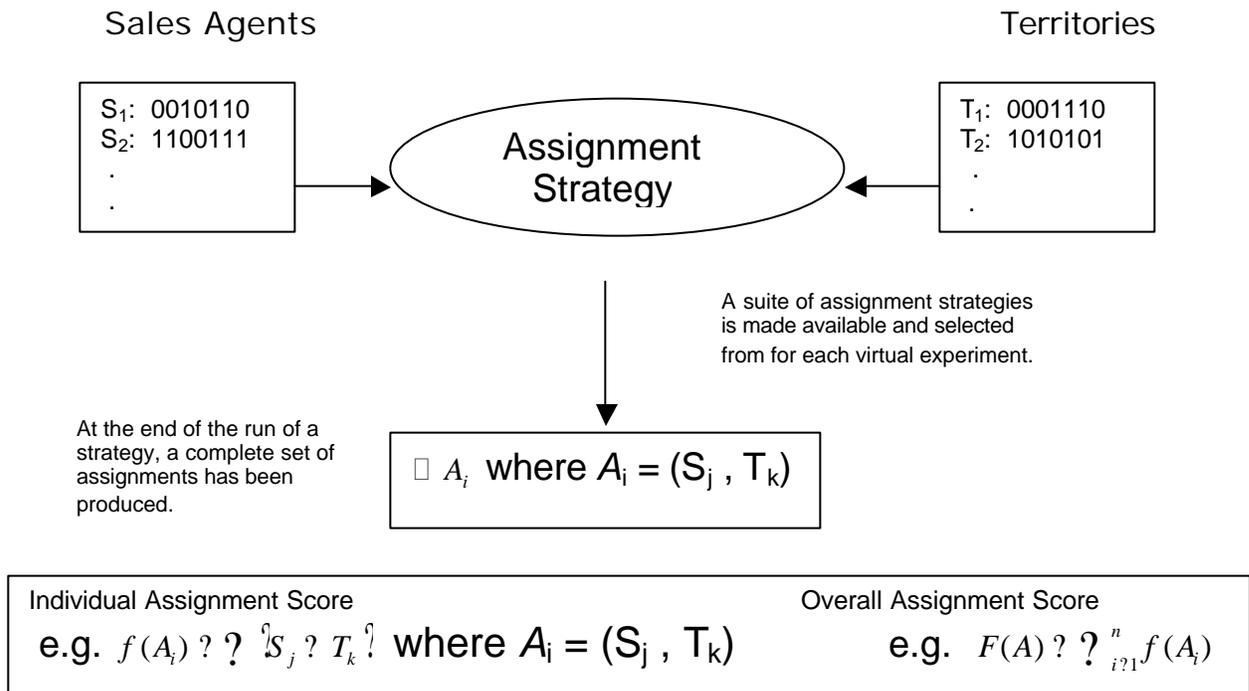


Figure 2. Block level description of the simulation for the virtual experiments

One motivation, perhaps the most defensible motivation, for studying organizations is to improve them.

James G. March (1999) states that "(a) central dilemma in modern organization theory and operations research is the mismatch between the analytic capabilities of human institutions and the complexity of the environment in which they function. Although large bureaucratic institutions are impressive extensions of the already impressive intelligence of individual humans, they seem persistently to be imperfect instruments for solving the problems they face." (James G. March, *The Pursuit of Organizational Intelligence*, Oxford: Blackwell Publishers Inc., 1999, P. 173.)

The persistent imperfections may have more to do with the difficulty of the problems than with the analytic capabilities of human institutions for even a simple problem such as the one examined here.