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Efficient assessment of organizational action based on knowledge space theory

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Abstract

This paper shows how knowledge space theory can be adapted to an organizational context for the efficient assessment of action in an organization. The research mentioned here was presented and discussed elsewhere (Stefanutti, Cristante, & Tommasini, 2001); in this context we just take it as an example for illustrating some relevant features of a particular class of models derived from knowledge space theory, called 'action structures'. In this paper we show (1) how an action structure is constructed in practice and which kind of phenomena it allows to model; (2) how this model can be used in a practical situation for assessing the operating state of an organization.

1 Introduction

Action structures are discrete mathematical models for the representation of the organizational process of a given class of organizations. Within the action structure approach, a single *organizational event* is a discrete portion of the organizational process. Typically, it embodies human action and it can be described linguistically. The *domain of action* of a given class Ω of organizations is the set E of all organizational events that can occur in organizations belonging to that class. The *operating state* of a single organization is the collection A of all events in E that have occurred in that organization. Finally, an action structure for the class Ω is the collection $\mathcal{A}$ of all the operating states that can be observed in organizations belonging to Ω.

In this paper we use results obtained in a research project developed in Italy to show some of the main features of action structures, as both models of the organizational process, and tools for performing assessment in an organizational environment.

The reseach on which this illustration is based was accomplished within a project for the development of a computerized tool for monitoring some Italian social services oriented to the prevention of youth desease (*youth joining centers*). At the time of the research, youth joining centers (YJCs) represented a new kind of social services in Italy (they exist in this country since the beginning of last decade) and, as a consequence of this, the flow of organizational events and actions was not much structured and known. One (implicit) purpose of the research was, thus, to provide these centers with a more structured representation of their activities that could be shared by people working in a single YJC, as well as across different YJCs. The study reported here was limited in scope, as it concentrated to centers located in three villages within the district of Mantova (a small city in the north-east area of Italy).

In this report we show (i) how an action structure was constructed for representing the organizational flow characterizing the three Italian centers (Section 2); (ii) which was the

resulting model and what the model explains about the organizational process of those centers (Section 3); (iii) how this model could be applied in order to perform assessment with respect to a single YJC (Section 4).

2 Construction of the action structure

The construction of an action structure for the three centers mentioned in the introduction required many different tasks. The main steps are summarized in the following points:

STEP 1. **determination of the domain of action** of the YJCs; basically, this operation consisted in collecting an exhaustive number of relevant *organizational events* that typically occur in these centers.

STEP 2. **construction of the action structures** for the three YJCs; the method of construction was *expert query*[1] Three highly qualified experts (one for each center) having a role as coordinators of the centers were engaged in a computerized query session for extracting the necessary information about the relation characterizing the events in the domain of action.

STEP 3. **test of agreement among experts**; by expert query, three different models were obtained (one for each center). The aim of this step was to compare the three models to each other and to provide a statistical measure of the agreement/disagreement among the three experts.

STEP 4. **model integration**; finally the three structures were integrated and a single model containing information shared by the three experts was obtained.

3 Overview of the resulting model

In order to give an example that is simple enough, but also realistic enough, we provide a description of a fragment of the original action structure obtained with the methods described in Section 2. We consider, thus, a subset of 21 events belonging to the original domain of action, and the corresponding substructure. The events in this example were chosen so as to cover the entire organizational process that goes from the initial political negotiation that precedes the setting up of a youth joining center, until the actual opening of the center to the users. The choice of these events is also justified by another, more technical, criterion that will be specified in a moment.

3.1 Surmise systems

Before to present the model, some remarks on the different (but equivalent) forms in which an action structure can be represented are needed. The standard representation of an action structure is as a collection of operating states (subsets of the action domain). This representation is efficiently handled by a computer. The same cannot be stated for humans, expecially when the number of states in the structure is rather large (and this is the case of our example). However, if the structure presents some specific mathematical properties (closure under both union and intersection) it can be represented through a Hasse diagram and, in this case, it is called a *surmise system*. Even when the number of states is large, a Hasse diagram (that, basically, is a graphical representation of the structure) turns out to be much more readable and understandable.

A surmise system is a Hasse diagram (thus, a directed graph representing a covering relation) whose nodes are events in the action domain, and if an arc connects two nodes then the event represented by the lower node is a prerequisite for the event represented by the

[1] see, e.g., Kambouri, Koppen, Villano, and Falmagne (1994) for an example of an application of this method to another context.

upper node. Then, by transitivity, an event a is a prerequisite for another event b whenever there exists an ascending path departing from a, that connects the two nodes.

The fragment illustrated here turns out to be closed both under union and under intersection, thus it can be represented as a surmise system. This is not surprising, as the 21 events were explicitly chosen to satisfy this criterion. Note however that, in the general case, closure under intersection is not required for an action structure.

3.2 Model description

A representation of the surmise system corresponding to the substructure on 21 events is depicted in Figure 1. Events are represented by numbered nodes and a short description of them will be given in a moment.

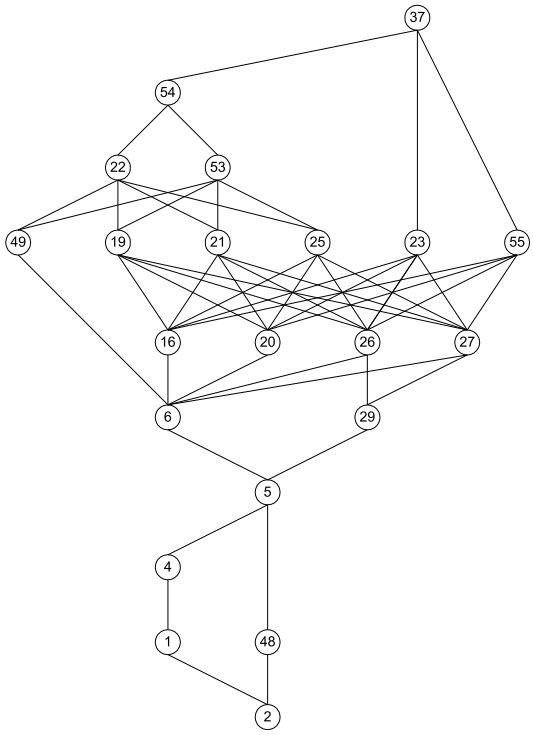

Figure 1: Surmise system representing an action sctructure on the 21 organizational events

After a first inspection of the surmise system, it was not difficult to identify five different *phases* of the organizational process: (I) a first phase characterized by an initial political negotiation (events 1 and 2); (II) a second phase in which administration processes dominate the scene (events 4, 5, 6, 26, 27, 29, 48); (III) a third phase characterized by the organization of the service (events: 16, 19, 20, 21, 49); (IV) a fourth phase in which the main activity consists in the promotion of the center (events: 22, 23, 25, 53, 54, 55); (V) the last phase in which the center is opened to the users (event: 37).

PHASE I: Political Negotiation. First, note that the number of events in this phase is relatively small, if compared to phase III. This, almost surely, reflects the role of the three experts within their organizations (coordinators of the centers). Political and administration aspects are not the main subject of their work. However all the experts recognize the existence of this political phase at the very beginning of the process.

The need of a political phase at the beginning of the process is justified by the consideration that, in Italy, this kind of social services are, in some sense, optional. Italian law

establishes some structural and functional standards for these services, but the choice to provide a specific community with a YJC depends on decisions taken at a local level (usually, by the Municipal Council). This decision is affected, among other things, by the budget that is available to the council, as well as by the needs of the community itself.

In this situation, the role of Councillor for the Social Services (or equivalent political entity) is of crucial importance. He promotes the service, and starts a negotioation process for obtaining an approval by the Municipal Council.

PHASE II: Service Empowerment. In this phase the staff of the Department for the Social Services of the Town Council (head of the social services, social workers, etc.) have a crucial role. Once obtained an authorization from the Municipal Council, this staff starts a formal procedure for setting up the social service (in this case a YJC), and it establishes contacts and relationships with the entity that will manage the center in practice. Such entity may be either a private company (the usual case), or a public entity (e.g., a special section of the Town Council itself). In the first case a contract between the Town Council and the private company is required. As a consequence of this, events 6 and 29 represent two alternative possibilities.

PHASE III. Service Organization. The main entities involved in this phase are the employees of the YJC. The staff of a YJC is tipically made up of a coordinator and a variable number of social operators (usually, educators). This staff is mainly concerned, in this phase, with projecting and scheduling the educational work. They develop and extend the basic structural features of the service (human and phisical resources acquisition and allocation). Moreover, the educational contents of the service are defined.

PHASE IV. Service Promotion. The main objective of this phase is to promote the service through appropriate advertisements, and by setting up connections and relationships with other local agencies (social network) that deal with minors (school, social consulting service, families, hospital, etc.). The aim is to get the center acknowledged by the other local agencies and by the social context in which it works.

PHASE V. Service Opening. This is the last phase in our example and contains only one event: the actual opening of the center to the users. As it can be seen, before to reach this event, the political, administrative and educational staffs have to solve a number of intermediate questions, constantly moving among different overlapping contexts (the political context, the administrative context, the educational context, and the social context are some of them).

4 How to use the model for assessment and planning

We are now in the position to show how an action structure can be used for identifying the operating state of an organization, and for planning action in order to reach a specific organizational goal. In our illustration we make use of the model presented in Section 3.

Before to get into our example, some remarks on the kind of assessment that is implied by the action structure approach are needed. Section 4.1 explains, in short, non-numerical assessment and its main features. Then, an example of how to identify the operating state of an organization by means of a simple deterministic procedure is presented in Section 4.2.

4.1 A short remark on non-numerical assessment

Within the approach followed here, non-numerical assessment of an organization corresponds to computing the set-difference between a set of objectives of the organization, and its current operating state.

Suppose that the domain of action of a class Ω of organizations is E, and consider a specific organization ω belonging to Ω. Let $(\mathcal{A}, E)$ be the action structure for the class Ω, and $T \subseteq E$ be a fixed set of goals (the *target set*) of the organization.

The first step of the assessment corresponds to the identification of the current operating state A of the organization, which is a member of $\mathcal{A}$. A deterministic procedure for the determination of the operating state of an organization is discussed in details in Section 4.2. Here we suppose that A was successfully determined by an application of that procedure.

The second step of the assessment consists in comparing the operating state A with the target set T. Clearly, the intersection $H = A \cap T$ is the set of all the goals already reached by the organization, and the difference $D = T \setminus A$ tells us which are the remaining goals.

Now suppose that $T_n \subseteq E$ represents a *check point* in the sense that it contains all the goals that the organization should reach within a given time point $n > 0$ on the basis of some standard criterion. In this case, $D_n = T_n \setminus A$ represents the *conformity* of the organization to the standard criterion at time point n. Clearly, the criterion is fulfilled at time n only if D_n is empty (in which case, of course, $A = T_n$).

4.2 Assessment: an example

In this section we present an example in which the operating state of a fictitious YJC center is uncovered by means of a deterministic assessment procedure using, as a knowledge base, the action structure delineated in Section 3 (that we indicate here with the notation $\mathcal{A}$). In our example, an employee of the organization is queried by means of such procedure. Since the procedure is deterministic, some (unrealistic) assumptions about the operator are needed. In particular, we assume to query an 'ideal' operator that never makes mistakes (i.e., neither random error nor systematic error are present). Note, however, that in practical situations the simple procedure exemplified here is replaced by more sophisticated probabilistic procedures that take into account some kind of random error in the data obtained from the operator (see, e.g., Falmagne and Doignon (1988)). These more sophisticated procedures are based on the essential concepts illustrated here.

Questions to the operator are of the form: "did event e occur at least once in the organization?", where e is an event in the action domain E of the organization. The response of the operator can be either positive (YES) or negative (NO). The assessment takes place in a certain number of steps. In every step a single question is posed to the operator, and the aim of the procedure is to minimize the total number of questions required to uncover the whole state of the organization.

At the outset (step 0 of the procedure) there is no information at all about the state of the organization, apart from the fact that it should belong to $\mathcal{A}$. Thus, the degreee of uncertainty is maximal: the state of the organization is one of the members of $\mathcal{A}$. Let $\mathcal{A}_0 = \mathcal{A}$ represent this fact. Then, at every step $k > 0$ an event is chosen from E, and the operator is presented with the question "did event e occur at least once?", and a new collection $\mathcal{A}_k \subseteq \mathcal{A}_{k-1}$ is obtained on the basis of the response of the operator. If the response is positive then $\mathcal{A}_k$ will contain all states in $\mathcal{A}_{k-1}$ containing event e. Otherwise, it will contain all states in $\mathcal{A}_{k-1}$ not containing event e. It can be shown (Doignon & Falmagne, 1999) that the procedure terminates in a finite number $m > 0$ of steps, and $\mathcal{A}_m$ contains exactly one state A_m that, in the deterministic case, represents the operating state of the organization. To improve the efficiency of the procedure, in every step k an event e is chosen so as to maximize the quantity of information (Doignon & Falmagne, 1999).

Now, in a practical example, suppose that the first event chosen by the procedure is event 20. Suppose that the response of the operator is, in this case, negative. Thus, the state A^* of the organization does not contain event 20 and it should be included in:

$$A_1 = \{1, 2, 4, 5, 6, 16, 26, 27, 29, 48, 49\}.$$

The next event chosen is 26. In this case the response is positive. Thus, A^* should include

$$A_2 = \{1, 2, 4, 5, 6, 26, 29, 48\},$$

that is, our information at this point is that $A_2 \subseteq A^* \subseteq A_1$. The third event chosen is 16 and, this time, the response is negative. Hence, the following set includes the state of the organization:

$$A_3 = \{1, 2, 4, 5, 6, 26, 27, 29, 48, 49\}.$$

Thus, $A_2 \subseteq A^* \subseteq A_3$.

The fourth question is for event 27. The response of the operator is now positive. Thus,

$$A_4 = \{1, 2, 4, 5, 6, 26, 27, 29, 48\}$$

is a subset of A^*, and $A_4 \subseteq A^* \subseteq A_3$. The fifth choice is event 49, and the response is negative. Thus, we obtain that

$$A_5 = \{1, 2, 4, 5, 6, 26, 27, 29, 48\}$$

is a superset of A^*, that is, $A_4 \subseteq A^* \subseteq A_5$ and it is clear that, at this point, the procedure terminates, as $A^* = A_4 = A_5$.

From this example we see that the deterministic procedure was able to uncover the state of the organization with 5 (of 21 possible) questions.

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