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Distributed Artificial Intelligence and Decision Support Systems :*a Multi-Agents System for Professional Check-Up*

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Abstract **Today, job requirements are more and more evolutive and uncertain. With the professional check-up, French government have chosen a social valorization logic. We present a Group Decision Support Systems (GDSS), a collaborative support system for evaluation and orientation of adult handicapped persons developed for a specific check-up center. In the first part we present the decision making process in this professional check-up. In the second part we give details on the general architecture, functionalities based on the previous modelization and on implementation with agents language of the prototype. Finally we conclude on the limits of the prototype and comments on the design and realization of such GDSS.**

I. INTRODUCTION*

The subject of our research is the collaboration support, particularly in a perspective of consensus elaborating, and consists in the design and the realisation of a Group Decision Support Systems (GDSS) prototype in the field of professional evaluation and orientation processes or professional check-up. In economics and management, the group decision support is now one of the main new ways of research in the Decision Support System area .

Today, job requirements are more and more evolutive and sometimes uncertain. It seems relevant to favour transversal abilities rather than specialised and narrow technical mastery [4]. In this way, the French government had chosen a social valorization logic, with the notion of professional check-up. This professional check-up is now a recognized right for every worker. The main goal of this check-up is to "arm" the individual, to make them autonomous and responsible, in order to enable them to negociate the knowlegde they have acquired. The main professional check-up functions are [4] :

- to identify and valorize acquired knowledge accumulated through professional experience or training,
- to verify and evaluate abilities with adapted means,
- to gather necessary elements for the elaboration of an individual project of insertion and professional qualification.

In practice, the check-up is composed of three main phases : reception and preliminary interview, introspection and acquired knowledge valuation, and finally use of results to build strategies for the future.

II. DECISION MAKING PROCESS OF PROFESSIONAL CHECK-UP

A. Description of the check-up center activities

This research concerns professional check-up for adult handicapped persons. We have worked with a pilot center specialised in evaluation and orientation of adult handicapped persons, the Interdepartemental Preorientation Center of Marseille. During the last ten years, this center has conducted several thousand check-ups. Its activity is performed by a multidisciplinary team of physicians, trainers, psychologists, psychomotricians, instructors of various technical and tertiary workshops, etc. Every week, a special commission (Cotorep) sends an average of six new trainees for check-up to the center. These persons stay in the center for a period of 8 to 12 weeks. Throughout the year, there are an average of 40 trainees in the center.

This general check-up process concerns first an evaluation of abilities of the handicapped trainee to compensate his handicap, then a definition or a re-definition of his professional project according to his abilities, and finally the proposition of an orientation. We can observe three periods in this process, each linked to a specific check-up :

- initial check-up : in the first week, this check-up establishes a first evaluation of the trainee's abilities and project and to define for him a relevant advance in the various workshops or evaluation units for the following weeks.
- intermediate check-up : every week this check-up gathers together the person in charge of the orientation and all evaluators, in order to adjust the advance of every trainee through the various evaluation units.
- final check-up : when the evaluation is satisfactory, this check-up permits to define by consensus evaluation and orientation proposition for the trainee. This orientation can consist of various propositions such as a specific training, a job in an ordinary firm (with some adjustment of working conditions) or in a specialised firm, a return to medical treatment or establishment of a work inaptitude. This proposition is communicated to the trainee and to the Cotorep commission..

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B . Modelization of the professional check-up process

This professional check-up has to be studied as a decision process developed through a close collaboration between members of a multidisciplinary team. Each member has his own competencies, his own sensibilities. The complexity of this process and the necessity to take into account each member's specificities require the consideration of an important set of criterions. Consequently we have adopted an multi-criterion approach [1] [11]. This approach permits to enlargen the reflection on the choice of solutions in the choice phase of the decision process, and also the criterions and solutions elaboration of the design phase of this process (phases of the decision model defined by H.A.Simon [12]). This multi-criterion approach is already used in design and development of DSS devoted to one decider [3] [8] [10].

The evaluation and orientation processes developed in the center can be understood as the research of a consensus between several evaluation units or sites. This consensus concerns the trainee's abilities and the orientation proposition which will be suggested to him and the Cotorep commission, proposition adapted to these abilities and to his professional project. Sometimes, this professional project does not exist, consequently it will be necessary to define it with the trainee, to adjust it according to the revealed abilities along the evaluation process.

We call "evaluation unit" all professionals (physician, psychologist, ...) or workshops which contribute to reveal abilities and professional project of the trainee. For this revelation professionals use interviews, and workshops use a set of exercises organized in progression which they propose to the trainee.

Evaluation criterion levels and abilities emergence

To each exercise or interview are associated a set of criterions to evaluate. These criterions can be specific to a given evaluation unit and often depend of the personality of the person in charge of this unit. Consequently, for many criterions which have to be taken into account, this person defines his own evaluation metric according to his sensibility. So, we can define two different criterion levels, the local level specific to evaluation units and the consensual level, defined as consensual for all units, permitting to establish the trainee's "portrait" (in terms of abilities). The figure 1 illustrate these two criterions levels.

Note that a criterion defined for the local level of an evaluation unit can be taken into account by other units with the same or a different valuation metric. Such a local criterion can directly take part in the portrait of the consensual level. It can also take part in the portrait through combination with other local criterions according to aggregation methods (to be defined at the local level).

The trainee's abilities are deduced by successive abstractions or specific reasonings from criterions of the trainee's portrait. Abilities revealed can be used for several finalities, for instance the research of an orientation proposition for a job in an ordinary firm, or for a specific training. This diversity of finalities permits to take a maximum benefit of evaluations realized by the various units to elaborate the orientation proposition following different strategies.

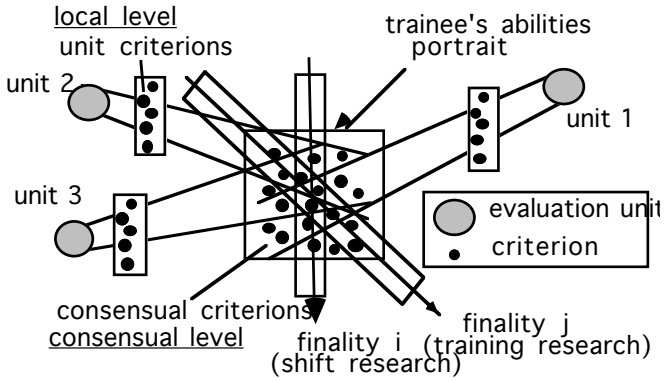

Fig. 1. The two criterion levels (local and consensual)

Dynamics of the decision making process

To present the dynamics of the check-up process we split it into two distinct processes, the evaluation and orientation processes.

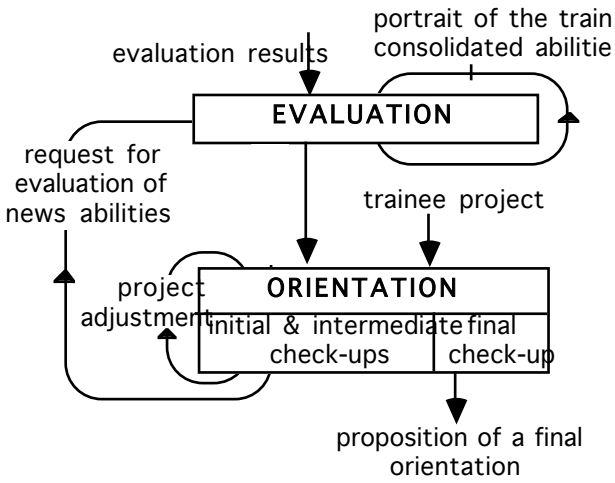

Fig. 2. Links between evaluation and orientation processes

At the local level (in an evaluation unit), the evaluation process concerns the choice of exercises to be proposed to the trainee, the collection of evaluation results to these exercises. After a coherence control, theses results are integrated at the consensual level. This integration permits the emergence or confirmation of abilities and to consolidate the trainee portrait.

The orientation process concerns the definition of requirements associated to an orientation project, then the confrontation of trainee abilities with requirements of a given project, the validation, the adjustment or the renunciation of this project and the proposition to the trainee of a new orientation project more adapted to his revealed abilities. This process is developed in the center through the various check-ups (initial, intermediate an final).

As the previous figure illustrates, these two processes are closely and iteratively linked. So, the way out of the orientation process may be to go back to the evaluation process, e.g. in order to confirm some already emerged abilities or to evaluate new abilities. The dynamics being defined, now we present the prototype's architecture and functionalities, based on this modelization.

III. PRESENTATION OF THE PROTOTYPE

A. General Architecture of the prototype realised

The general architecture of the prototype is based on three main modules : the analysis module, the orientation module and the evaluation module. These three modules are knowledge based systems in close interaction with human actors: requirement analysts, career advisers and ability valuers. Theses modules are linked to different data bases of jobs, associated requirements, local and consensus criterions for ability evaluation (some of these data bases are part of the information system of the check-up center). The following figure illustrates this architecture :

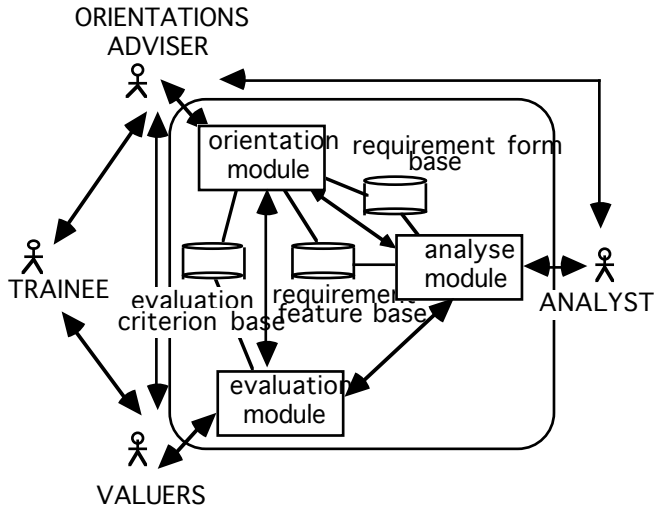

Fig. 3. General architecture of the prototype.

B. The Analysis module

This module offers an assistance to the requirement analyst, actor whose job it is to analyse (or interpret) possible orientations and define the requirements associated. These orientations can be functions (generic job descriptions), specific jobs proposed by firms, or training programs proposed by various training centers. For this prototype, we have only considered functions.

Requirements linked to a function are defined according to a "requirement feature". A set of features has been defined and is memorized in a feature base. A feature can be linked to one evaluation criterion or to an ability (macro-criterion) which can be built on several evaluation criterions. A specific metric is associated to each feature, permitting to express the acceptable requirement level for a given function. It is possible to precise strong or weak contra-indications.

The realized prototype permits the user to elaborate for a given function the requirements form associated, which refers to a feature base. The system permits to store, to modify and to restore these requirement forms on graphic profiles. For one requirement form we have several profiles which are associated to a set of abilities of the same nature or related to the same methodological approach. In a given profile, the user can indicate if a feature is eliminatory or not, or if a feature can be compensated by one or several other features. For every feature, an importance degree (priority degree) can be defined. This importance degree is taken into account in the confrontation of requirements and trainee abilities.

C. The Evaluation Module

The aim of this module is to assist professionals and workshop responsibles to collect evaluation results. This module concerns principally the evaluation criterion base. This criterion base has been constituted from several interviews conducted by these persons. For each responsible, we have observed his evaluation process. To perform these interviews and their exploitation we followed the KOD method, a knowledge engineering methodology [13]. Out of these interviews we have extracted for each evaluation unit a set of evaluation criterions and we have validated a consensual criterion base (hundred around). A particular unit is only concerned by a sub-set of this base and several units can informe a same criterion.

This module permits to collect a trainee's evaluation results to an exercise, for instance. When results are keyed in, the system performs coherence controls. These controls can be simple (value range), or more complex, e.g. related to coherence models attached to exercise. Then, this module permits the integration of these criterion values from the evaluation unit into the consensual level, to consolidate the trainee's abilities portrait. This integration is realized with integration methods. The system controls if the gap between value to integrate and consensual value meets a condition. From values of criterions the module permits to deduce by aggregation the values of other more abstract criterions such as abilities. In the prototype development we have adopted for integration and aggregation methods simple arithmetic average, (more complex methods can be implemented)

D. The Orientation Module

This module assists the career adviser who has to confront project requirements (function requirements) with trainee abilities which have been revealed during the various evaluations in the different units of the center. His good knowledge of the evaluation units enables him to elaborate for every soft feature a "constructor" which permits to deduce feature values from consensual criterion values. The first functionality of this module is to assist the user to elaborate these constructors.

This module also helps the user to define for a trainee his progress through different evaluation units by proposing him a schedule of units to visit. This help is based on the fact that every requirement feature is linked to a set of criterions to evaluate and that every unit also evaluates a set of this criterion. Importance degrees defined for this feature (analysis module) permit to propose a relevant progress.

The main functionality of the orientation module is to evaluate gaps between requirements and abilities profiles. These last profiles are obtained by projection of abilities values of the portrait on requirement features associated to the function considered. The conclusion of this gap analysis can be to suggest an acceptation, a way out or recommend new evaluations for specific abilities. This gap analysis is performed according to reasoning rules. For the prototype, only a sub-set of such possible rules is implemented. The following figure shows the screen resulting of such an analysis with track of rules used :

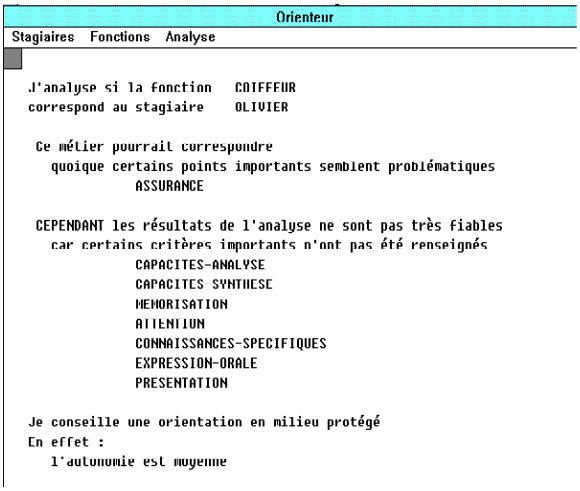

Fig. 4. Screen resulting of gap analysis with track of rules used

Another main functionality of this module is to research functions which seem more adapted to revealed trainee's abilities in the base of function requirement forms. This functionality allows the user to propose a new, more realistic project to the trainee. A last functionality is to simulate other possible orientations, e.g. other functions, with simulated ability values.

E. Implementation of the prototype

For the implementation of the prototype we have chosen techniques from Distributed Artificial Intelligence (DAI). DAI concerns the design and realisation of multi-agent systems [2] [6]. The prototype modules are realised with an agent language, the AGORA language offered in REALM, a DAI environment developed in Golden Common Lisp (on MS-Dos Windows 3) and distributed by the Advisia Company. The choice of these DAI techniques is justified by the complex treatments to be carried out on different criterions of the local and consensus levels, treatments which also concern metrics, aggregation methods and reasonings associated.

The AGORA language uses concepts which come from frame languages are based on attribute, class, inheritance and reflex notions. Each data manipulated by a program is described by the attributes which characterizes it. These attributes can be of value or procedural type. A procedural attribute describes a behaviour that the agent can exhibite when it receives a specific stimulus. Data sharing the same attributes can be grouped in classes, and the creation of a new element of same characteristics corresponds to the creation of a new instance of this class with an inheritance mechanism. Introduction of new values at some attributes can activate specific actions, for instance the verification that this new value is included in a given interval of values. This mechanism is completely supported by the agent language AGORA and correspond to the activation of a reflex (demon).

Data structuration in the prototype

The main data of the prototype are structured as an agent society. The different prototype's agents are criterions, evaluation units, requirement features and trainees. The criterions are the main agents and have an specific role. The following figure illustrates the structuration of a subset of prototype data in class and instances :

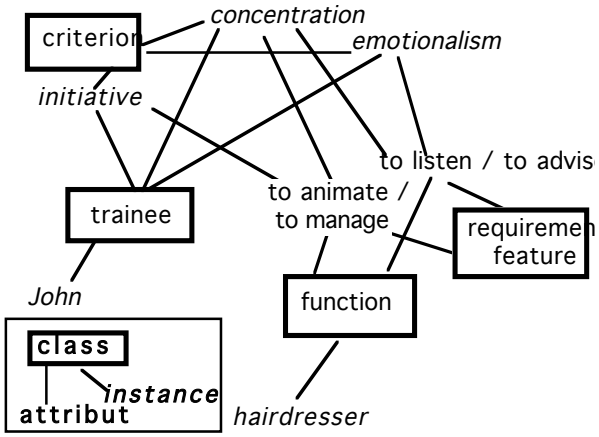

Fig.5. Structuration of a sub set of prototype data

The data structuration uses notions of class and instance of class. Basic classes used in the prototype are evaluation units, functions and trainees. For each class, criterions are represented by attributes and have an unspecified value. A given trainee, a given function or a given evaluation unit are an instance of the basic class associated. Attributes (criterions) are evaluated for each instance. The following instructions are an example in AGORA language of class and instance declaration and insertion of a new value to an attribute :

```
(def-agent metiers :class t
        :attributs (:ph
                ((:att gerer-organiser :val 0)
                 (:att veiller-controler :val 0)
                 (:att acceuillir-contacter :val 0)
                 (:att aider-conseiller  :val 0)
                 (:att concevoir-etudier :val 0)
                 (:att animer-diriger :val 0))))
                        ------
(def-agent reparation-materiel-jardin
        :classes (metiers))
                        ------
(=>entite 'aide-comptable 'gerer-organiser :def 5)
```

Agents dynamics in the prototype

Previous data can be manipulated in different situations : the insertion of a new element in the data base, the function definition according to requirement features, the trainee evaluation in each evaluation unit and finally the comparison of trainee abilities with requirement features associated to a given function. In each situation, the prototype behaviour is defined by activation of reflexes attached to an attribute of specific class or instance. The insertion of a new element in the data base corresponds to the activation of a creation reflex of the instance or the class associated.

Interface

The interface is not realized with the AGORA language. It is programmed in Common Lisp language. All elements composing this interface (windows, dialogue objects,...) are developed according to the same agent principles.

IV. CONCLUSION

Group Decision Support Systems constitute a new research field for DSS searchers. These systems concern the group decision support, concerning not only the problem solving phase but rather the problem finding or problem setting phase, which is an fundamental phase [5] [9]. Individual and group decision contexts are very different. In group decision, it is necessary to take into account new dimensions related to the group, its members and the context of their collaboration. These new dimensions are still ill understood [7].

At the term of this research, the following observations related to limits of the prototype and to project continuation can be made. First, the prototype functionalities have been summarily developed and a complementary development is necessary. The conceptual modelization that we have elaborated and used for the prototype design seems to be relevant. It seems that these functionalities can be improved with the introduction of fuzzy logic. The fuzzy logic would permit to better take into account the imprecision of evaluation results associated to technical imprecision and psychological behaviour of the evaluator. It also permits a more subtle gap analysis between abilities and requirements.

To conclude, the realization of GDSS, and more particularly, collaboration support systems, seems to be promised to large development in the future. These systems have to permit the improvement of the quality and even the productivity of group working. In the conception of such systems, the modelization of group decision processes is fundamental to understand these processes and imagine the support which can be provided. This modelization has to be deeply studied in order to propose methodological elements to help the designers. For the realization of these systems, multi-agents systems, (associated to Distributed Artificial Intelligence) seem, by their flexibility, to be particularly adapted.

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