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LEVELS 0? DECISION MAKING AND CERTAIN PROBLEMS OP ARTIFICIAL INTELLECT

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Pecularities of Decision mpicing processes on eeneo-perceptual and speech-thinking levels are described. The productive oharactes of these processes are demonstrated.

One of the traditional ways of artificial intellect constructing is an analysis of real decision making processes of man and subsequent formal description of them. Heuristic programming, however, representing to many scientists mind an acme in realising this approach has not approved hopes, pinned on it neither practical* nor theoretical ones (see,for example, 3,4).

Prom the psychological point of view the initial position of heuristic modeling pf thinking (in particular the program of Common Decision Maker Problem by Newell, Simon, Show) contradicts to the principal characteristics of mental processes: a)to their reflective character (they are the reflection of objective world, but not an operating by simbols); b)to active character of this reflection (mental reflection is not a passive reproduction of outer world objects, it is not a reproductional choice, sorting of already acquired knowledge, it is cogaition, i.e. It is an active productive "bailing* from objects new and new content by means of including them into new systems of relations/ l / .

On the present stage the research of man cognitive processes having been significantly realized in connection with de-

cision making (DM) problem.

In this paper it is supposed to analyse the peculiarities of decision making on a perceptive - identificative level (signal detecting, visual perception and identification, uncoding of aerophotographs and so on) and on speech-thinking level (operative tasks solving, in which the main purpose is to construct a mode of action)*

There are many classifications of decision making situations. To characterize tasks being solved on different levels we use one of these classifications*

V.V.Drudehinin and D.S.Kontorov /2/ consider three types of decision making situations (systems), informative, operative, organizational•

Informative decisions are to answer question[1] what is trully?* and consist in situation diagnosis ('situation distinguishing[1] according to the authors' terminology).

pperative decisions are to answer question 'how to act' and consist in working out a mode of control*

Organizational decisions are to answer question 'what for a system or an organization it must be?' and consist in structure determining and in functions distributing in * supposed organization.

Mentioned above classification permits to consider DM on perceptive-identificative level (perception and identification tasks) as informative decisions and working out a mode of acting by operative tasks solving as operative decisions.

There are two basic stages in DM processes: infoimative preparation of decision (stage of 'predicision' according to P.K.Anochin) - search and distinguishing information about situation, building its image; and procedure of DM itself - construction or actualization cf hypotheses about an object; working out a principal and a program of action.

Psychological Peculiarities of Decision Making on Perceptive^

The process of solving a perceptive-identificative task and especially its stage of informative preparation of decision is closely connected with search operations, with searching stimuli, with searching indications of objects, being completed by forming object image.

One of the authors researched foiling perceptive image in the process of perception certain sets of figures representing arbitrary combination of straight and curve lines. PhaBe character of this process was demonstrated in this research.

In the first phase of perceptive image formation a position of figure in visual field relative to basic coordinates of space, general sizes and proportions of the figure and basic colour are reflected.

In the second phase reflection of the most sharp overall of figure counturs and its basic (the biggest) details takes place; specification of the figure colour characteristics in going on here.

In the third phase differentiation of figure small details and specification of its colour characteristics take place.

In the forth phase forming adequate image is being completed and its correcting is being carried out.

So a substancial psychological characteristics of a perceptive image forming and search operations, providing it, is an intensive analitical-synthetical activity with distinguishing different indications of object in different phases of process*

Analogours data were recieved by one of the authors by researching perception and identification of complex single and group objects (noisy images). Objects alphabet consisted of 18 stimuli with 10 gradations of resolution (from 7 to 40

min/mm)•

Two levels of information processing were demonstrated: 'topological* and •cathagorical'. On the former level (up to 10 min/mm) there were distinguished two underlevels: a)grouping not clear 'blurrs' relative to their sizes;b)grouping not clear images according to 'topology[1]; c)inner-group differentiation.One the latter level (above 10 min/mm)there were distinguished underlevels of grouping and differentiation of objects configurations as semantic 'formations' in conformity with their classes (underclasses) and types, i.e. it is being carried out section concretization.

Researches of group compositions have shown that by significant distortion of an image by noises the losses of its elements could be compensated in cases of usage of outer obstacle steady indicators and also by increasing idea activity (imagination) and thinking activity. Dispute the fact that this process is being carried out already beyond the limits of image resolution the aim of identification could be reached.

It has been demonstrated in experiments that the process of perception has an extensive search character and includes to more or less extent indicative components, taken from previous experience, it seems to counter only on separate sections.

The process of simple objects identification has completely different character. This process is curtailed and has no clearly distinguished stages, it is based on different ways of observing and on different operative units of perception. It is typical for identification a sharp shortening indications distinguishing process by preserving a definite set of familiarising components. In outer plan minimization comes to direct 'output' into symmetry axis or to figure centre, to excluding several regions from analysis, to more regulated observation of remained regions. In inner plan minimization comes to usage of different combinations of Indications owing to distinguishing them, enlarging and posterior semantic coding. Identification actions are realized in different time regimes.

In table 1 is shown a quantitative comparative characteristic of processes of perceptive studying and identifying on the level of basic multitude (definitions of object type according to the main parameters of eye movement during perception tasks solving).

Table 1.

Comparative characteristic of perceptive studying and identifying processes (average data)

Characteristic process	Duration (sec.) of task solving	Duration (sec.) of fiesation	Quantity of fiesation points	Distribution of trajectory parameters (%) translational movements	Distribution of trajectory parameters (%) return movements	Distribution of trajectory parameters (%) inove-ments
Perceptetu! dy-i£ £	9'[2]* °'36		14	29 • 42	16	42
iden-tifi-estion	3,Q0	0,28	6	10	50	25	25

The search of given objects against 'motley' background as it takes place in the tasks of decording is more complecated. The strategy of objects search in decording processes has different character, depending on given task, content of decording objects, stage of searching and efficiency of operator. Particularly on the stage of complex objects analysis and simple objects search there were revealed three types of searcht chaotic, choising or search itself and search by semantic analysis. For chaotic system-

less search is typical dependence on its dynamics, on physical strength of stimuli perceived, there are absence of plan in work and low degree of communication here. For choising search is typical definite sequence in decording: a) movement according to planned search directions on the base of using inner samples and comparative analysis of perceived objects (parallel identification of objects), b) classification of perceived multitude upon relative submultitude on base of using outer samples (in aerophotograph itself) and comparative analysis (successive identification of objects). Search by semantic analysis is based *on* course and effect associations correlation interconnections among situation elements. For this search is typical creating prelimenary system of hypotheses about content of studied situation. It is going an intensive analysis through synthesis. In the result of additional analysis certain hypotheses are thrown away* several hypotheses are confirmed and different ones are corrected. The decisions in complex perceptive-identificative tasks are connected not only with rechoising hypotheses, but building them, as well.

The DM stage on perceptive-identificative level, as we have already mentioned, includes operations of building and choising hypotheses and collating them with formed image of object.

For clearning general dynamics of process of hypothesis building there were carried out experiments on identification of noisy photoimages of geometrical figures with i2 resolution gradations (from 5 till 35 min/mm) in different time regimes (from 0,3 till 1,5 sec).

Depending on task and physical conditions of experiment the choice of hypothesis can be realised on different levels. The knowledge of information a priori provedes possibility of output to final level omitting a number of intermediate ones. In case of difficulty in hypothesis choising on the level of basic multitude there could be transition to less concrete levels. Experimental researches testify that different perceptive and semantic indications including integral ones are used on every informative level.

The psychological analysis of the DM stage by digits recognition (inscription according to McWorth) and of the Russian alphabets letters (with exposition time about 30 me) allowed to reveal the connection *of* this stage with level of perceptual image formingness and level of standard generalisation. As experiments showed, the whole number of standards', from which singling out is realized, becomes actual by perception of each digit. In addition to this, the number of actualized 'standards' (the length of a series) is different for different digits. The indications by which the collation is taken are also changing

It turned out that by repeated expositions of the same digits subjects applied to other standards while recognizing them. It can be supposed that by multiple identification of an object it is collated every time with different 'standard* ('alphabet') systems depending on what phase of Image forming the collation is being carried out. One can say that those indications which man can uses by identification are sliding and depend on dynamics of image forming. Doing it subjects collate every time the perceptual image only with a small quantity of 'standards' changing those indications according to which the collation is taken.

One can suppose that 'standards' search shortening is also conditioned by the fact that each of them is a generalized image of objects category. 'Stan*

dard' generalization accounts also for possibility of identification of objects which have not been met in previous experience but have features common with those objects which have been met.

Thus DM processes on a perceptual identificative level - especially when DM is being done under difficult conditions - are characterized by the following peculiarities:

1. These processes as on the stage of information search and perceptual image forming, so on the proper DM stage have productive character expressing in:

a) constant joining an object of perception or identification in new systems of connections by means of analytica-eynthetical activity (indications alphabet changing, alphabet's 'sliding' character),

b) changing a generalisation level of objects[9] indications (transition from perceptive indications to semantic ones, enlargement of operative perception units).

2* DM procedure on this level is oarried out to a considerable extent not owing to actualization and sorting out, but owing to hypotheses constructing.We think that the latter circumstance is very important, as the situation of singling out sorting out hypothese is considered in the most works on DM problem (ref.2,4) as typical for a DM process.

3. A DM stage is substantially determined by a preclding standard of gaining lnfoxmatlon, by a character of perceptive image. In other words,the image takes part in the process of actualization and singling out hypotheses not only as an objeot of collation, but also as an substantially thing; its features provide selectivity of hypotheses actualization.

a - c abd
a - e acf

Figure 1

gavohologioal features of DM on a m)fl*ch-th1nking level

One of the most important aspects of DM problem is that DM tasks solving,first of all for action aims.

Or saying it in other words, DM is DM [on] action, on a definite mode of action in a gi^en situation.

In the psychological analysis of intaTttflUW flgciflfrpff processes allows us to draw a conclusion auout substantial relations existing between different cognitive results of a DM process (between 'sliding' images and formed hypotheses or actualized ones), the operative decision analysis (i.e. decision* about an action mode in a situation) has to answer the question whether the same substantial relations exist between cognitive and iperational components of DM. In other words, we must obtain an answer to a question whether an operational scheme is conditioned by cognitive activity or operational object's transformations are • symbolic', formal activity. (We would remind you that just in the latter sense this question is considering in heuristic programming).

One of the authors has developed experimental tasks in which an action mode construction is the most important aim of subjects. In general the task consisted in disposing on a surface six objects designated by letters 'a', 'b','c', 'd', 'e', 'f on the basis of knowledge about the mutual disposition of these objects (for example, a....b, a....d, see figure 1). This disposition was given by a logical condition of the task, and a 'cue' to the usage of this condition was given in an instruction. Figure 1 shows the result of solving one of tasks (i.e. required configuration of six objects).

For analysis purpose we considered actual action modes of subjects as unity of a reflective component (the action principle) and of an operative one (ope-

rational scheme, action program).

We shall understand by the action principle (AP) a factual (not always conscious, or verbalized) reflection of properties of both a base and others ob.iecte of transformation, really participating in activity regulation, (That object is called 'base', from which the subject begins his decision, i.e. which he fixes first of all).

By the operational copponent (OC)we understand such a real operation system. with help of which a situation transformation for goal achievement 1B being carried out.

In our case transformation situation, consists of objects 'a[1], 'b[1], •c[1], 'd[1], •e[1], *f[f] together with their relations (disposition with respect to each other).

But these objects are not homogeneous in regard to an amount of relatione (i.e. in regard to the quantity of fceigihbours[t], or objects with which they are standing side by side). The objects standing in the middle pointB of the configuration (see figure i, the objects [f]b[f] and c[1]) have three relations, i.e. they are standing side by side simultaniously with three objects. The other four objects 'a*, 'd[1], [f]e[f], ′f[l] are disposed at the extremes of the configuration and *axe* standing side by side only with the two objects. This nonhomogeneity of objects in logical task conditions is fixed by the quantity of conditions per object: the objects having two relations are represented by three conditions (three couples). It is sufficient for task solving to single out and fix two objects having three relations (all six objects will be incircled and fixed in the configuration). Thus the presence of objects with three relations is an essential property of the transformation object.

We succeeded in singling out three levelB of AP and three levels of OC respectively. These levels have analogous hierarchic structure in which the reflection character of task conditions is fixed and first of all, the degree of singling out essential properties of the transformation object. The third level is the hieghest, the most general (it is characterized by singling out two objects having three constraints).

Analysis has showed that interrelation of levels of AP and OC is characterized by the following peculiarities:

An operational scheme is falling behind from the appropriate level of AP.Besides that, thiB falling behind is related with frequency characteristics (the rize of AP level occurs faBter than the rize of OC level) and time characteristics. In particular the construction of an operat jnal scheme of the highest level occurs later than achievement of this AP level.

Thus there have been revealed in our experiments on operational task solving, the following characteristics:

i. Essential dependence of an action program content (an operational scheme) on action principle (the reflective component),

2. Tendency in the course of task solving to relization of these components at the graving level of generalization.

3. Regular falling behind of OC froa P in time; besides that, its overcoming is possible only in the process of speciал activity on OC construction at the level of achieved AP (or in other words,OC is not an automatically consequence of AP). It can be suggested that the noted incoincidence of AP and OC levels is a sufficiently typical characteristic of various types of man activity. Evidently this fact of relative independence of e stage of operational action schema construction was a base for its absolutization and known oposition of cognitive activity of man in the theory of heuristic

programming*

4. Shown by us a fact of a special construction of an operational schema proves that an operative task solving doesn't necesserialls mean down a situation of selecting an action mode from possible ones. The last is only a peculiar case of DM about action at the level of speech-thinking processes.

1* The processes of informational preparation of dlcision essentially determine the procedure of DM on all levels of DM. On a perceptual-recognizing level it is expressed in peculiarities of information search and the level of formingness of a perceptual image that provide selectivity of actualization and construction of those or these hypotheses. 3y forming action mode (on a speech-thinking level) this is expressed in corresponding generalization level of an action program to the generalization level of the action principle although the foostone falls behind the latter.

2. The process of DM at the both stages (preparation and DM itBelf) is productive 'bailing* a new content from an object by means of including it in new and new systems of relations. It results in changing the generalization level of singled out propertiee of an object (showing up more substantial properties of an object, changing its indications alphabet$_y$ enlargement of operative units of perception).

3* The DM procedure consists as a rule not in a mechanical sorting out but in selective actualization or hypotheses construction (on a perceptual-recognizing level), or in a special construction of an action mode (on a speech-thinking level)*

4* Psychological peculiarities of DM being showed up in experiments allow to suggest that simulation of mentioned above characteristics inherent in all levels of man *DM* can become one of the effective approaches to artificial intellect problem solving.

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