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NEW APPROACH TO MODELING DEEP INTUITION

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Introduction and problem setting. Report discusses general approaches to solving four interrelated problems:

a) study and mathematical modeling of possible mechanisms of deep intuition, as the basis of perception-action in a critical situation;

b) development of practical recommendations to accelerate the development of maritime academies cadets expert intuition among;

c) based on the results of task a), development of new methods of cognitive computation in conditions of radical uncertainty in order to assist vehicle operators in difficult situations (Maritime Situation Awareness; Assistive Technologies using AI; Urgent computing);

d) development of technologies for constructing cognitive transport systems (CTS), including "Symbiotic Autonomous Systems".

To solve these problems, it is necessary to understand nature of deep intuitive processes, develop an appropriate formalism, and develop recommendations for improving teaching methods [1]. The report provides general outlines of such a formalism based on paradigm of limiting generalizations (LGP) [2, 3].

Research in the field of cognitive computing, CTS [4] is aimed at developing machines, vehicles and assistants that are able to autonomously perceive environment and interact with it like a living being [5]. For CTS, it is necessary to quickly and efficiently process large amounts of data, to identify complex relationships and dependencies. Also, using algorithms close to human thinking, and develop solutions. This is necessary so that managing specialists, for example, vessels operators [6-8], can quickly make a choice of necessary actions. An example is AI assistants for transport operators based on IBM Watson. Another example is "Center for Operational Control of Marine Disasters of Fishing Fleet Vessels" (the project "Intelligent Technologies of the XXI Century") [9]. It is also important to note large European project "Symbiotic Autonomous Systems" [10].

Main research material. The well-known American psychologist Myers David, in an interview in 2012, made the following assessment: One of the biggest revelations of recent psychological science is the two-track human mind, which features not only a deliberate, self-aware “high road” but also a vast, automatic, intuitive “low road.” [11]. This fact also emphasized by Nobel laureate Daniel Kahneman in his bestseller "Thinking Fast and Slow" [12].

Two Systems Theories - TST, assumes that decision making is based on two cognitive systems: one automatic, intuitive and mostly unconscious (System 1), and the other reflexive, rational and fully conscious (System 2).

Dreyfus S.E. as the basis for the work of expert intuition (Expert Intuition) proposed System 0 [13]: System 0 is the most fundamental of all behavioral brain systems - the procedural memory system. He argues that action or reaction in familiar situations should not be seen as “decision making”, “thinking” or “mental activity” in the usual sense of these terms: “System 0 doesn't think, in conventional use of the word, it simply knows how ”. In fact, we spend most of our adult life exhibiting internalized intuitive forms of experience that are so easy to take for granted. These are cases when people automatically, quickly and effortlessly know how to act in familiar situations [14-16], without being able to explain their actions. Dreyfus actively argues with Kahneman and most cognitive psychologists who consider quick intuitive reactions in terms of decision making (System 1). Dreyfus's conclusion is that "Associative System 1 is not a correct explanation of expert intuition."

While agreeing with Dreyfus about need to consider System 0, it should be noted that he did not offer a constructive (working) model of System 0. Indeed, the paradox of System 0 is that there are no “decision-making problems” in conventional sense (i.e. “ tasks "with a conscious setting). However, since there is competition at all levels of brain processes: examples are Neural Darwinism, concept of “A Thousand Brains” [17]. Consequently, it becomes possible to approximate the situation, bringing it to a "task form" - implicit problems of choice, selection, discrimination, as well as implementation of decision / execution procedures (functional systems, radicals) [18]. Such an approximation allows us to consider hypothetical (formal) mechanism of emergence and functioning of System 0 “the Nature of System 0”, which is what is done in this report.

System 0 will be defined as follows as " LGP -interpretation". System 0 - A system for processing and storing information, in which neither the formulation of discrimination tasks, nor their solution are realized (metaphors - "The Dark Matter of Mind / Intelligence", "Deep Intuition", "Task Continuum"; Direct Awareness; Cognitive Awareness). The work of system is based on implicit structures and memory processes, deep implementation up to automatic selection / control procedures. System 1 is a subset of System 0; utility of distinguishing processing and thinking that is unintentional, spontaneous, and autonomous from that which is intentional, deliberate, and controlled. Information processing in System 0 is carried out without cognitive control, which sharply reduces energy, and also predominantly without resolving uncertainty (this is main characteristic of systems for which it is advisable to apply a quantum-like description).

One of pioneers of deep learning, Yann LeCun, posted an article on Facebook AI portal in March 2021 entitled “Self-Supervised Learning: The Dark Matter of Intelligence” [19]. He writes: "If artificial intelligence systems can gain deeper and more detailed understanding of reality beyond what is specified in training dataset, they will be more useful and ultimately bring artificial intelligence closer to human-level intelligence."

The working hypothesis of the study is that generalized knowledge of world or common sense constitutes the bulk of biological intelligence, both humans and animals. In a sense, common sense is the dark matter of artificial intelligence. " LeCun believes that "self-learning is one of most promising ways to accumulate such basic knowledge and approach common sense in AI systems." A general self-learning technique, according to LeCun, is “to predict any unobservable or hidden part (or property) of input from any observable or hidden part of input” (Self-supervised learning is predictive learning).

We believe [3] that System 0 together with outline networks, inductor space, mental space-time, patterns and multiphysics fully corresponds to the metaphor "Dark Matter of Mind", since this is largest volume of implicitly processed information in mental sphere ... Our goal is to propose a constructive model of this key system, along the way uncovering the secret of self-learning (the essence of sketch networks is precisely to "get a deeper and more detailed understanding of reality beyond what is indicated in training dataset", i.e. "generalized knowledge about the world ").

System 0 is a fundamental component of a world-like cognitive system. This is fundamental difference between LGP-interpretation of "Self-Supervised Learning" from interpretation of LeCun and others. The predicative aspects of self-learning in software are implemented. Implementation became possible in model of intuition, total internal audit of information, soft measurement, "connectome-cognitome", causal models. This made it possible to recover the missing parts of data, in "arrow of time", in mental space-time. These tools make it possible to work effectively with radical uncertainty in conditions of highly limited resources [20-22]. This is possible due to ability to quickly identify a competitive set subjective parameters order of development situations on the basis of minimum information in form the concept "thin slice" and "internal codes". By means of these processes, didactic tools for development this ability in academies cadets, and particular, marine specialties, are analyzed [23].

The expediency of considering System 0 is actually substantiated in [2]: the concepts of “continuum of tasks”, “inductor space”, “connectome-cognitive”, “digraph of test values / domains”, “digraph of image sketches”, “critical sketches”, “arrow of cognition ”, “Basis of limiting knowledge models”, “thin cut”, “internal codes”. The work of deep intuition is almost completely invisible, unconscious, but results of its voluminous work affect all aspects decision-making, which is reflected in practice [24-26]. And it is an approximation of behavior (metaphor - the underwater part of iceberg), creating situational awareness (Awareness-Based Decision-Making Strategy, Situation Awareness). System 0 is believed to be at heart “Jury of Intuition”, an essential internal audit and information forecasting mechanism.

A fragment of mathematical formalism: cognitive numbers [3]. The transition from physical reality to mental (psychic) reality is carried out mainly with help of networks sketches, which are responsible for the generation of information super-redundancy and super-diversity (explosive growth of entropy). ***Sketching information symbolizes the growth of its understanding***. As a rule, more sketches of a phenomenon / image / object, better understanding of this phenomenon / image (“the whole has more of its parts”) and more chances of finding acceptable “critical sketches” in discrimination problems (minimizing entropy based on self-organized criticality). Here are some examples of sketch networks.

Any number-value of any test has multiple interpretation, which makes it possible to define such a dynamic subjective entity as "cog-number". Example: "Body temperature = 38°C" $\rightarrow$ "Temp. high "$\rightarrow$" Temp. Not the norm. " Any natural sensor forms cog-number, cog-signs. In fig. 1 shows structural (fractal) inflation in dynamics - meaning generation - cog-number x of some test A (Temporal morphogenesis, Morpho-evolution with learning; Foundations of Quantitative Thought: Aim is to explore a unifying account of cognitive processes that shape quantity judgments under a variety of conditions; that involve judgments of number, space, time, and probability).

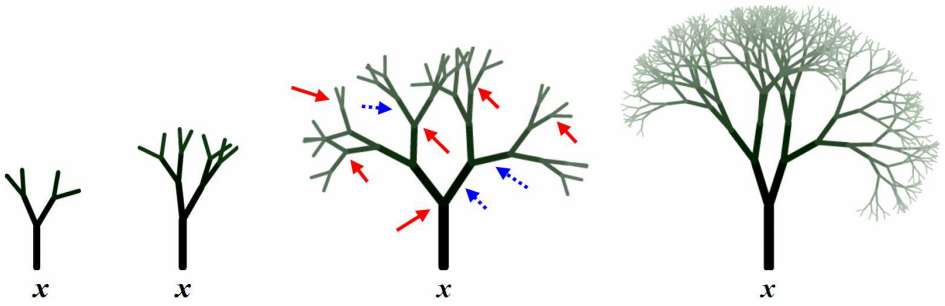

Fig. 1 - Structural inflation of the cognitive number *x* of test *A*

The 'tree' / nodes of sketch network provide an internal interpretation of original number / value. In process of subjective inflation, the cog-number 'grows'. In the middle image, for example, inductors are shown, which also "mature" in process of gaining experience and are part of cog-numbers. Moreover, there are inductors for nodes and connections (arrows of different colors and types). Inductors realize intuition. In addition, test A participates in certain observations / events and, therefore, in “arrows of time”. The latter, along with inductors, implement generalized test entanglement, as well as form a variety of contexts and affordances. The granularity of any observed test value is based on both “Controlled Hallucination” and “Creative Imagination” (contexts form “arrows of time”). In this context, it is interesting to compare concepts of “cog-number”, “fuzzy number”, “p-adic number” and “gray number”.

Conclusion. Due to description of state an arbitrary dynamic system by vector of cognitive numbers, we obtain LGP-concept of a multiscale phase space. Each scale level forms its own sketch the dynamic system behavior based on its own physics of processes.

Each cog-number within a given test has its own network of sketch-interpretations. Combining at each moment of time developing networks all numbers-values test A of sketches, we obtain a general network the test of sketches of , which, in some cases, can be represented as a digraph of test domains G(A) (example in Fig. 2; circles are domains, from bottom to top is

generalization; base / bottom domain is numeric; Temporal morphogenesis) [3]. Each domain is an implicit task of distinguishing System 0.

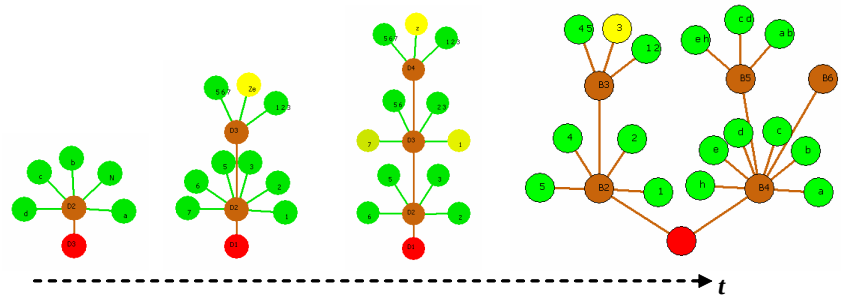

Fig. 2 - Example structural inflation stages of test G(A) domains digraph

This study assumes application in predictive systems for identifying critical situations in ergatic systems of maritime transport.

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