RUDN Journal of Philosophy. ISSN 2313-2302 (print), ISSN 2408-8900 (online) 2023 Vol. 27 No. 4 878—887
Вестник РУДН. Серия: ФИЛОСОФИЯ http://journals.rudn.ru/philosophy

https://doi.org/10.22363/2313-2302-2023-27-4-878-887
EDN: SVNHWH

Research Article / Научная статья

"Common Denominator" in Solving Multi-Factory Problems by Intelligent Systems

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Abstract. The most important property, a distinctive feature of any intelligent system, is its decision-making ability. In this case, the more complex the problem to be solved, the more and more diverse the initial data, and the more critical it is that the decision to be made was comprehensively considered and evaluated. In many cases, simultaneously arriving various initial data, if considered separately, and decisions based on such consideration lead to completely different results, often contradicting each other. Therefore, in the process of development and implementation of artificial intelligence (AI), it is especially important to investigate the "mechanism" of decision-making in conditions of the inconsistency of incoming initial data and the need to establish some generalizing rule, according to which it is possible to find a harmonizing solution taking into account various influencing factors. It is evident that when establishing the rules of decision-making, it is necessary to strive for a "positive" result from the point of view of the problem being solved. This undoubtedly requires analyzing the consequences of the decision made in a set time scale, which can be provided by appropriate feedback that will allow us to make the necessary corrective actions. Artificial intelligence in modern forms of practical realization has, as a rule, a digital embodiment. It should be taken into account that the digital representation of data inevitably shows an inaccurate display of initial values when processes of a continuous nature are considered and analyzed. Since a digital model has certain limitations and characteristic properties when analyzing and processing initial data, it is logical to assume that for this reason, there can be some general approach, some general rule, according to which a decision is made in the conditions of diverse initial data and the need to take into account the relevant consequences after the decision is made. This paper attempts to find a decision-making mechanism, harmonizing it according to the incoming external and available internal input data.

Keywords: artificial intelligence, sensory perception, basic emotions

Article history:
The article was submitted on 20.08.2023
The article was accepted on 16.09.2023

For citation: Adzhemov AS, Denisova AB. "Common Denominator" in Solving Multi-Factory Problems by Intelligent Systems. *RUDN Journal of Philosophy*. 2023;27(4):878—887. https://doi.org/10.22363/2313-2302-2023-27-4-878-887

«Общий знаменатель» в решении многофакторных задач интеллектуальными системами

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Аннотация. Важнейшим свойством, отличительной чертой любой интеллектуальной системы является ее способность принимать решения. При этом чем сложнее задачи, чем больше и разнообразнее исходные данные, тем важнее, чтобы принимаемое решение было всесторонне рассмотрено и оценено. Во многих случаях одновременно поступающие разнообразные исходные данные, если их рассматривать в отдельности и принимать на основе такого рассмотрения решения, приводят к совершенно различным результатам, часто противоречащим друг другу. Поэтому в процессе разработки и внедрения искусственного интеллекта (ИИ) особенно важно исследовать «механизм» принятия решения в условиях противоречивости поступающих исходных данных и необходимости установления некого обобщающего правила, согласно которому можно найти гармонизирующее решение с учетом различных влияющих факторов. Совершенно очевидно, что, устанавливая правила принятия решения, необходимо стремиться к тому, чтобы оно имело «положительный» результат с точки зрения решаемой задачи. Это, несомненно, требует анализа последствий принимаемого решения в установленном масштабе времени, что может быть обеспечено за счет соответствующих обратных связей, которые позволят вносить необходимые корректирующие действия. Искусственный интеллект в современных формах практической реализации имеет, как правило, цифровое воплощение. Следует учитывать, что при цифровом представлении данных неизбежна погрешность отображения исходных значений, когда рассматриваются и анализируются процессы, имеющие непрерывную сущность. Поскольку цифровая модель обладает определенными ограничениями и характерными свойствами при анализе и обработке исходных данных, то логично предположить, что по этой причине может существовать некий общий подход, некое общее правило, согласно которому принимается решение в условиях разнообразных исходных данных и необходимости учета соответствующих последствий после принятия решения. В данном исследовании проведен поиск такого механизма принятия решения, гармонизирующего его согласно поступающим внешним и имеющимся внутренним исходным данным.

Ключевые слова: искусственный интеллект, чувственное восприятие, базовые эмоции

История статьи:
Статья поступила 20.08.2023
Статья принята к публикации 16.09.2023

Для цитирования: *Adzhemov A.S., Denisova A.B.* "Common Denominator" in Solving Multi-Factory Problems by Intelligent Systems // Вестник Российского университета дружбы народов. Серия: Философия. 2023. Т. 27. № 4. С. 878—887. https://doi.org/10.22363/2313-2302-2023-27-4-878-887

Introduction

In numerous literature sources, the definition of an intelligent system is based on the concept of artificial intelligence (AI), which in turn, having different editorial interpretations, is reduced to the fact that whether it is a program for a computer, some device or apparatus, the result of the work of which will be what a person is traditionally engaged in [1—3]. The question of artificial intelligence and its definition can have various, sometimes controversial, and debatable interpretations. At the same time, the fundamental concepts — *thinking*, *consciousness*, *intelligence* — do not have unambiguous definitions. At the same time, the sharply increased complexity of AI creates fundamentally new threats in the sphere of cybersecurity. The danger of unethical use of AI appears [4]. Concerns about the autonomy of artificial systems in a self-developing reflexive-active environment are growing, the consideration of the subjective factor in the creation and use of AI systems [5—7], the possibility of providing AI with justifications for its decisions in natural language [8] are becoming increasingly relevant.

In this paper, we will consider a narrower problem — how, in the conditions of diverse tasks and the availability of multiple and often contradictory initial data, AI can make certain decisions. It is not important whether these decisions are correct or not since the very concept of "correctness" requires a separate consideration and definition. What is of interest is the very mechanism of how a decision can be made, how a particular decision variant is chosen from possible alternatives. In this context, AI is of particular interest with the range of problems and tasks that *Homo Sapiens* has to solve.

Some Problems Solved by a Person and a Calculator

Consider examples of what a person faces daily and what problems he must solve. Quite a wide range of tasks, especially for adults with certain knowledge and life experience, are solved as if by themselves. Their solution is obvious and does not cause any difficulties. At the same time, problem-solving is a process occurring in time and culminating in some action. For instance, accidentally, having put his hand on a hot object, a person will instantly solve this problem and pull his hand away so as not to get burned, obeying the corresponding received signal.

Based on our common sense, the decisions made and the resulting actions are logical and correct. However, suppose that a result of a sharp and not very careful movement, trying to avoid burns, a person breaks an object worth 10 million rubles.

How can we now assess the correctness of the decision made as a result of which this happened?

The provided example shows that when making a decision, as a process is unfolding in time, it is only sometimes possible to take into account all the consequences of it. Therefore, the correctness of the decision can be assessed not only as the result of processing the set of initial data available at the moment but also as an assessment of the consequences of the decision. Artificial intelligence, which is formed based on some rules, including those that allow it to change and improve, should consider this fact and be able to predict. However, let us return to the problem of how the decision itself can be formed.

Suppose you ask any modern person what is more than one second of something whole, for example, of an apple or one-fifth of the same whole. In that case, the answer will be received immediately, and the person will look at you with astonishment with an expression: "What a strange question? It's obvious!". However, suppose a similar problem is formulated with other initial data, for example, what is greater than 245787/159393 or 27010/17516. In that case, the correct solution will require some time and, most likely, a simple AI called a calculator.

The solution of the calculator, as a representative of the simplest AI, will be obtained much faster than it will be done by a human unless, of course, we take into account the unique talents of notable people who have developed in themselves the ability of super-fast counting. Moreover, here, the calculator will still come out the winner.

The explanation of such a result in the competition between a human and the most straightforward AI is clear — the calculator solves one strictly formalized task and is incapable of anything else. Nevertheless, a human, or rather his biological intelligence (BI), must solve many other tasks besides arithmetic calculations. That is why BI is organized in a completely different way, considering the need to find solutions in conditions of the multifactor nature of solved tasks and often considerable uncertainty. Besides, in its physical embodiment, BI has certain peculiarities, and it is not just an arithmetic device solving strictly defined formalized tasks according to a given unchanging algorithm. BI can not only solve but also set itself a variety of tasks, as well as anticipate the consequences of this.

It is known that the large hemispheres of the human brain are functionally asymmetric. As a rule, the left hemisphere is an analog of a counting and analytical device. The right hemisphere provides the emotional and sensual perception of a person of a set of initial data coming from the external environment due to the available opportunities — to see, hear, smell, taste, and touch with the help of corresponding "peripheral devices" working according to specific protocols with the internal BI, as well as due to the "internal" work of the BI, based on the information resources accumulated earlier, as well as on the work carried out by the internal BI.

Besides the named five senses, which have been formed in a human being during a long historical period, in some publications, it is possible to meet the

indications of human intuition and also several other sensual sensations of a human being, e.g., on feelings of thermoception (feeling of heat), equibrioception (feeling of balance), nociception (feeling of pain) and others, including additionally feelings of hunger, thirst, danger, and others.

Depending on genetic features, as well as the influence of external factors, each person's sense organs may be developed differently in the process of formation and subsequent changes in their work in combination with BI. As a result, some people will have the same sensual sensations. In contrast, others will have completely different sensations at the same initial data, which is realized in the emergence (formation) of corresponding emotions. A simple example — the same musical work will cause a rapturous emotional reaction in one person and boredom in another.

Many works are devoted to research on feelings and emerging human emotions. Paul Ekman, for instance, singles out seven basic emotions [9], Carroll Izard — ten [10]. Table 1 shows a comparison of known classifications.

Table 1. **Basic emotions**

Robert Plutchik (1927–2006)	**Paul Ekman (1934–present)**	**Carroll Izard (1923–2017)**	**Silvan Tomkins (1911–1991)**
Joy	Joy	Enjoyment	Enjoyment-joy
Trust			
Anticipation		Interest	Interest-excitement
Surprise	Surprise	Surprise	Surprise-startle
Disgust	Grossness	Disgust	Disgust
Sadness	Sadness	Sadness	Sadness
Fear	Fear	Fear	Fear-terror
Anger	Wrath	Anger	Anger
	Disdain	Disdain	Disdain
		Remorse	
		Shame / shyness	Shame-humiliation
			Guilt

One can also find a more extensive list listing dozens of gradations of one basic emotion, both conditionally positive and negative (ref., e.g., Table 2). There are studies on the influence of various emotions on human health [11] etc.

The strength of emotion manifestation is influenced by temperament, which, according to most psychologists, is innate (Table 3). Since temperament, differences are formed that influence BI's decision to choose one or another variant of behavior in a given situation.

Why is one person shy, afraid of appearing impolite, incompetent in some way, and maybe even ridiculous in the company of his good acquaintances, and another person, regardless of the people around him, both acquaintances and strangers, behaves in a completely different way? However, he may be incompetent and rude compared to the first one. Analyzing this distinction, a researcher cannot help but wonder how to take into account the multitude of such diverse influencing factors to determine how a BI, in all this diversity, makes certain decisions.

Table 2. **Table of emotions**

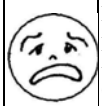
Joy		Sadness		Anger		Fear	
	Pleasure Vigor Revitalization Satisfaction Calm		Sadness Sadness Loneliness Bitterness		Dissatisfaction Irritation Annoyance Agitation		Confusion Indecision Uncertainty
	Fun Joy Excitement Cheerfulness Admiration		Despondency Spleen Sadness Suffering Helplessness		Anger Anger Hostility Aggression		Fear Stiffness Fear Anxiety Anxiety
	Jubilation Delight Triumph Ecstasy		Depression Depression Hopelessness Grief Despair		Fury Rage Hatred Anger		Panic Terror Numbness Nightmare

Table 3

Features	Temperament			
	Choleric	**Sanguine**	**Phlegmatic**	**Melancholic**
Poise	Bad	Good	Very good	Very bad
Mood	Unstable	Sustained	Sustained	Unstable
Emotions	Strong, short-lived	Weak, short-lived	Weak, prolonged	Strong, prolonged
Speech	Loud, uneven	Loud, smooth	Quiet, smooth	Quiet, uneven
Patience	Low	Moderate	High	Low
Adaptation	Good	Excellent	Slow	Bad
Contactability	High	Moderate	Low	Low
Attitudeto criticism	Aggressive	Calm	Indifferent	Offensive
Attitude towards new things	Positive	Indifferent	Negative	Uncertain
Behavior in difficult situations	Uncalculated	Calculating	Cold-blooded	Confused
Self-esteem	Significantly overestimated	Somewhat overestimated	Real	Underestimated
Exposure to influence	Moderate	Weak	Weak	High

How Certain Decisions Are Made

Let us identify the general rules of decision-making on the part of the BI to find answers to why, e.g., experiencing seemingly intolerable suffering, a captive does not betray his comrades. Why does an airplane pilot sacrifice himself, crash into an enemy column, etc?

Before formulating a hypothesis of how this can happen, let us pay attention to the peculiarities of expressions contained in a number, and maybe in all languages of human communication (at least in the languages known to the authors — English, French, and German). What expressions can mean: “I terribly

love," "I like terribly," "I apologize wildly," "I am terribly happy," etc. Understanding the individual meanings of the words *scary, terrible, wild*, and *creepy*, it seems illogical to use them in combination with the words *love*, *like, apologi*es, and *happy*. Nevertheless, we say so and assume it is natural.

The explanation, apparently, may be that it is a particular form of strengthening one's emotional reaction. Therefore, the words *scary, horrible, wild,* and *creepy*, besides their direct meaning, are the highest form of emotional evaluation. That is, it turns out that the scarier it is, the brighter and more vital it is, and so it can serve as the primary motivation for making an appropriate decision. Consequently, it is logical to assume that the decision is made depending on what is scarier. Fear becomes the common denominator we need to compare different alternatives, as in the above example of suitable fractions. A prisoner of war, while undergoing torture, does not betray his comrades because he is afraid of becoming a traitor, and that is scarier than his imminent death. So is a pilot who directs his airplane to ram enemy equipment. It is emotionally scarier for him not to fulfill a combat mission than to die.

There are many examples of such behavior when the decision leads to death, which is determined by what is scarier. Romeo and Juliet were afraid of losing each other, and they chose to go into the next world together. At the same time, of course, the concept of fear should be understood in an extended interpretation as some common denominator for comparison and making an appropriate decision.

There are a lot of examples, in reality, surrounding us on how to make a necessary decision. Appropriate information flows are directed at a person, emotionally intimidating him. The method of carrot and stick in its extended interpretation is applied everywhere. The figures of speech mentioned above ("I like terribly," etc.), although Charles de Talleyrand's aphorism "Language was given to a man to conceal his thoughts" is well-known, still prove that when making a decision, it is very likely that generalized fear is the common denominator that allows to make a comparison and develop an appropriate decision.

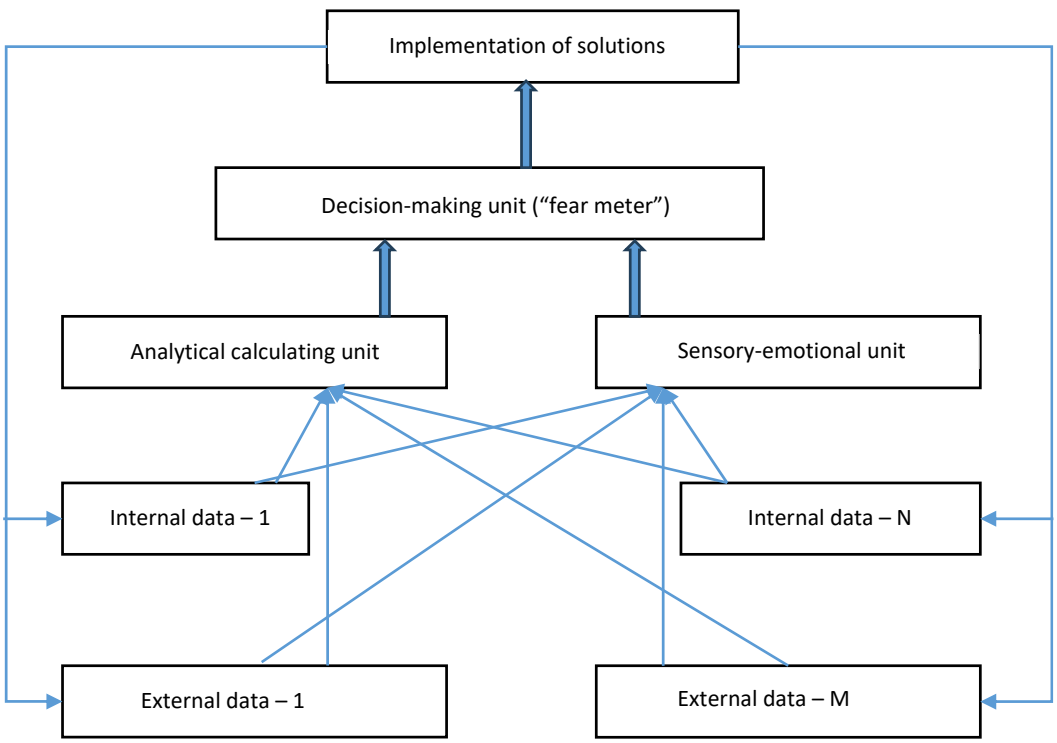
Let us represent the actions of BI in the form of the following flowchart (Figure) and use technical terms to designate individual blocks, thus emphasizing that similar blocks should contain AI.

BI works with internal and external data, which appear both due to a person's sensory capabilities (vision, hearing, etc.) and as a result of internal conscious, analytical activity. N internal data sources and M external data sources are indicated on the flowchart. Note that, moving on to a discussion of what an AI might have as input data, these lists, compared to BI, may differ.

The internal and external data are fed into a counting and analytical device and a sensory-emotional device, which in BI is realized through the available brain hemispheres. The results of the work of these devices come to the decision-making unit, where a decision is made based on comparison using the principle of "common denominator," i.e., it is necessary to do what is more terrible.

According to the decision made, appropriate commands are formed for its fulfillment. For instance, to drop everything and run away, to bow politely and

shake hands, to order a pizza, to start doing physics homework, and so on. Realizable decisions are linked by feedback to blocks of internal and external data, which again becomes the initial data for subsequent decisions and their implementation. It is this feedback that can serve as the source of data necessary for predicting and evaluating the consequences of decisions.



BI Flowchart

Considering human behavior, management of a team, company, or even a state, one can everywhere meet the principle of "common denominator," which is fear. In this case, the term *fear* should be understood as a generalized concept, although in its direct meaning, it is also present as a special case, one of the types of fears. There are many fears: fear for one's life, of the new, of loneliness, of responsibility, of the dark, water, heights, beetles, spiders, mice, cockroaches, fear of the future, of losing a job, being late for a train, fear of the boss, of coming to power of this or that politician, and many others.

Each personality's formation is formed based on genetic features, upbringing, and accumulated experience, and certain fear amplifiers are obtained based on counting-analytical and sensual-emotional activity. At that, one personality may have a lot of such lines, and another personality may have few, e.g., desires only to eat, drink, and sleep. Then, fears can influence only these lines. It is possible to characterize such personality as primitive and, at the same time, to understand that influence on it can be rendered only on these actual lines. Everything else is of little importance and will not work. Personalities with a more extensive range of fears,

on the other hand, make decisions from a much wider range of influencing factors. These people can be expected to demonstrate decisions when disregarding the fear of death, apparently one of the most "powerful" fears for obvious reasons. They perform heroic deeds in the name of more significant and higher goals.

Conclusion

The proposed decision-making model is an attempt to indicate an approach to the development of a general principle based on a set of initial data, often contradicting each other, taking into account not only their importance at a given time but also the available experience and the ability to predict the consequences, since all these processes unfold in time.

This model can be useful in the development of AI and in analyzing the behavior of real-life individuals, as well as collectives of people.

Of course, it is much easier to manage a primitive personality by forming a limited circle of influence along the lines of influence. However, this is the reason for degradation, as the mentioned limited BI does not favor the emergence of new ideas, new developments, or creative solutions. Therefore, the rigid command and control system should have limited application.

The proposed model allows us to develop reasonable methods of forming a personality that will be afraid of being uneducated, rude, deceitful, etc., which will eventually develop creativity, non-standardization, and creativity of solutions without harsh coercion and compulsion.

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