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Research Paper

Network Modeling of Rational Value Systems Interaction: Justification of the Basic Principles and Methodology

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Abstract. *Background:* the article is devoted to the study of the interaction of rational-value systems, thus being an integral part of the theory of rational systems. *Purpose:* the purpose of the article is to develop a methodology for network modeling of rational-value systems (RVS) based on the analysis of their interaction, proposing a classification of networks (egocentric, communicative, convergent and cause-and-effect) and substantiating their application. *Methods:* the main method of this work is network analysis used in social sciences. *Results:* the article substantiates the possibility of network modeling of rational-value communication. Both general principles and examples of a network model and a data window, as well as special cases in the form of network types are presented. The most promising include the egocentric and cause-and-effect network model. *Conclusion:* in the conclusion, conclusions and generalizations are made, further directions for the study of rational systems are formulated. This article briefly describes the basic principles of rational-value communication, provides an example of network modeling and windows of calculation data provided in a previously published article, but not included in it. In addition, this article expands the author's ideas in the direction of network modeling options.

Keywords: *Rational Systems, Rational Value Systems, Rational Value Communication, Theory of Rational Systems, Network Rationality*

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1 Introduction

Rational value systems (RVS) are a way of (self-) organization of being-in-relation; a concept that is both a method of social sciences and its content. Such a theory does not so much propose to think of the interaction of people, society, state and even technology as rational value communication, but rather proposes to select from all the communication produced by rational systems the one that meets certain criteria, namely, participation in the communication of such systems, in the structure of which there are two basic components: rational and value blocks, respectively [Kondratenko, 2020].

The RVS concept attempts to develop the system theory by identifying a special class of systems in it – rational systems. This is done in order to "purify" the system theory, including by ridding system abstractions of zoomorphic or technical analogies. Indeed, the problem is that the expansion of the system theory to groups of individuals and even society occurs due to the analogy with an enterprise (T. Parsons), an animal (L. von Bertalanffy), technology (D. Easton), etc. Network analysis partially attempts to solve this problem by replacing any types of systems and reducing the content of the systems that are part of the network. Thus, the theory of rational systems attempts to find a new balance between the internal and the external, rejecting reduction and analogies.

The RVS concept is based on many approaches. On the one hand, it is a general philosophical theory that identifies and studies rational and irrational elements in the structure of being: the world of ideas and the world of things ref39, physical and metaphysical dimensions [Kenny and Amadio, 2024], faith and reason [Undusk, 2012], spirit and matter [Hegel, 2018], the conscious and the unconscious [Freud, 1989], etc. On the other hand, these are psychological concepts of the value sphere of the individual. The significance of the value center of the personality over other structures was substantiated in the works of Tikhomirov [1969]. The value sphere of the personality was studied in detail by L. Vygotsky, S. Rubinstein [Bratus, 1985], [Leontyev, 2003], and others.

The concepts of "dynamic value system", "value-semantic sphere" and "value-semantic communication" have also been developed in detail in psychology [Ivkov, 2014; Popova, 2019; Artyukhova, 2016]. Thirdly, these are the ideas of Turing [1950] about rational machines, capable of thinking. If one day it will be possible to model the value block in technical systems, then such machines can also be classified as rational-value systems. The closest to the concept of RVS are the ideas of M. Weber on social behavior determined by value and instrumental rationality [Weber, 2019], J. Habermas on the life and systemic communicative worlds [Habermas, 1985], as well as the ideas of D. Kahneman on thinking dictated by System 1, aimed at solving situational problems, and System 2, working to solve complex and long-term problems [Kahneman, 2011].

The ideas of rational-value communication in one form or another are also heard in modern research. Thus, the idea of combining value and rational components can be found in studies of hybrid intelligence [Lim and Hwang, 2025], in which machine intelligence complements human intelligence, rather than replacing it. In RVS, rationality is also understood as an addition, organ, tool of the value block. Human intelligence is described in terms of flexibility, creativity, determination, instinctiveness, common sense, while machine intelligence is characterized by speed, efficiency, cheapness, scalability and consistency [Van der Aalst, 2021]. RVS also has the property of autopoiesis [Maturana and Varela, 1980], it can and should be thought of as a whole, as a "single whole" [Bianchini, 2023], but the contribution of other systems and individual components to this whole remains poorly understood. Network models of rational-value interaction will try to fill this gap.

There are quite a lot of studies related to the analysis of rational-semantic communication, so it makes sense to limit ourselves to the most significant ones. Thus, the idea of "zero" values is postulated in the theory of structural voids by Burt [1992], which promotes the emergence of new connections, the generation of ideas, and the emergence of innovations [Burt, 2004]. The division of network connections by strength was described by Granovetter [1973], which was reflected in the indicator "strength of value connection".

Convergent networks received their name thanks to Bormann's theory of symbolic convergence, described in various works, including the article "Symbolic convergence theory: a communication formulation" [Bormann, 1985]. This study will also mention the network concept of congruence, understood "as a similarity in broad or narrow assessments of the (un)desirability of actions, situations, or objects" [Wilms *et al.*, 2025] in two or more RVS. Finally, it is also worth mentioning numerous network studies describing various methodological aspects of network communication, in particular, the causal model is built on the intersection of the methodologies of causal topological networks [Lin *et al.*, 2024] and network analysis of rational choice [Feinberg *et al.*, 2020].

The concept of RVS is an integral part of the theory of rational systems. In addition to RVS, recursive-sensory [Kondratenko, 2022], isomorphic indeterministic [Kondratenko, 2023a], and rational-indefinite systems [Kondratenko, 2023b] [Kondratenko, 2023c] were identified and studied in detail. The theory of rational systems is an interdisciplinary theoretical concept created for the modern description of psychological, social and political processes in the context of digital transformation. With the help of the theory of rational systems, individual behavior, social relations and political systems, as well as human-machine interaction can be described. The theory of rational systems, in particular, has already been applied to describe political socialization [Kondratenko, 2024].

Previously, rational systems were divided into spontaneous and non-spontaneous [Kondratenko, 2023b], and also it was concluded that for spontaneous systems, rationality is generated from some irrational (or supra-rational) beginning due to the presence of another system with which it is necessary to build relationships [Kondratenko, 2023b]. For example, for the RVS, such a system is a value object, a copy of which it models in its value block. The rational block, with all its possible autonomy, functions ultimately to take care of the value object. However, the rational block can begin to play a dominant role in the structure of the RVS, but will it then remain an RVS?

The main hypothesis of the study is the possibility of limited application of the network methodology for modeling rational-value communication; such borrowing can only be formal, since the content of the RVS is capable of significantly changing the interaction model. To test this hypothesis, a "thought experiment" will be conducted, in which the main methods of network analysis will be used to test the possibility of expanding the theory and studying the results of modeling. This article examines not so much the architecture of the RVS as its interaction with other systems, an attempt is made to reveal the meaning of this interaction and the specifics of rational-value communication. Modeling assumes the presence of a certain "arbitrator" within the communication, the element that is least included in the communication itself. Such an element is the modeling block [1]: this follows from the structure of the RVS, described earlier in the 2020 article [Kondratenko, 2020].

At the same time, it is necessary to preserve the emergent, autopoietic autonomy of the RVS and introduce the so-called "subjectivity correction", understood in the context of the article as taking into account the influence of individual rational and value blocks on interaction in networks. It is manifested in the fact that each RVS interprets information and communication through the prism of its values, which can lead to distortions or multiple interpretations. For example, in egocentric networks, subjectivity is expressed through zero nodes that reflect unconscious needs or unfulfilled desires. In communication networks, subjectivity manifests itself in autocommunication, where self-referential loops emphasize the internal processes of the system. Causal networks minimize subjectivity, but it remains in the form of cognitive filters that influence decision making. Thus, an adjustment for subjectivity requires taking these factors into account for more accurate modeling of network interactions.

1.1 Ethical issues

The author believes that the theory of rational systems and the contribution made by this work will significantly expand the theory of systems and network analysis used in social sciences. This theory, used as a metabasis for theoretical and empirical research, can not only contribute to the growth of scientific knowledge, but also act as a kind of humanistic project of the 21st century, substantiating the unity and diversity of coexisting rational systems. Humans can and have already made significant steps in teaching machines rational-value communication. In addition, communication networks have not previously been described as rational-value networks, which, from the author's point of view, better reflects social interaction. A deeper understanding of communication, proposed in this article, can certainly contribute to humans' knowledge of themselves and the world in which they live.

2 Theoretical and methodological applications of rational value communication studies

2.1 Basic principles of RVS interaction

The process of modeling value networks, first of all, faces great difficulties caused by subjectivity: indeed, the value network from the point of view of one RVS may not completely coincide with the value network from the position

[1] For more details on the role of experience in modeling rational-value communication, see the author's publication "Research of Network Rationality: Justification of the Idea for the Computer Modeling Project of Rational-Value Communication", presented at the XXVII International United Scientific Conference "Internet and Modern Society" (IMS-2024, St. Petersburg, Russia, June 24-26, 2024)[Kondratenko, 2026]

of another system. Moreover, the point of view of one RVS component, for example, the value block (V-block), may also not correspond to the point of view of another element, for example, the rational block (R-block), and real communication may represent a third modeling option - behavioral networks. This problem cannot be reduced to one of the network types, therefore, it is necessary to consider each of these types and analyze their relationship.

Value communication is associated with the desire of the RVS to attract another system; the value relationship generates a process in which two systems, reducing the psychological distance [Trope *et al.*, 2007; Van Lange *et al.*, 2013; Fiedler *et al.*, 2012; Trope and Liberman, 2010; Cocking *et al.*, 2013], eventually become a single system. Value communication generates new systems, unions and alliances, but when modeling such communication, a complexity caused by distance arises. On the one hand, value communication generates three types of interaction between RVS: system-value communication, dialogic value communication and no communication at all, and in this sense, modeling can neglect the distance, while system-value communication arises, first of all, to the third RVS, in opposition to which a common position, norms, rules, etc. are asserted. It is well known that the presence of a common enemy contributes to the cohesion of the team.

On the other hand, if we consider not one, but two RVS, then the distance between them can indicate the average of the desired states of communication: for example, the desired state of one RVS is system-value communication (distance 1), and the other is no communication (distance 3), then the average distance will be 2. In a sense, the distance in this case will speak about the potential of communication, so it is better not to reject the idea of depicting the distance, but, on the contrary, to accept it and use it in the model. Despite the apparent lack of independence of the R-block of the RVS, the rational component nevertheless has an independent vision of interaction based on the satisfaction of rational interest.

In the context of rational-value communication, rational interest is realized in various forms: the absence of rational interests, situational rational interest, regulating and prescribing rational interest, completely or to a greater extent rationalizing communication between the RVS, and systemic rational interest. Again, the question of modeling arises. It is logical that rational interests arise in the process of interaction and grow or decrease in the scope of communication over time.

It is worth clarifying the meaning of rational communication of the RVS. Such communication in the ideal aspect does not pursue either egoistic or altruistic goals - it is precisely the joint and simultaneous satisfaction of rational interests [Smorgunov, 2018]. Rational communication of the RVS combines values-goals and values-means [Rokeach, 2008], constantly trying to find a balance in the development of each side of the communicative process. In a sense, the goal of rational communication of the RVS is an agreement on equality in the decision-making process, the establishment of rules and norms, the creation of a union or alliance. It follows that the model should somehow reflect the specifics of contractual relations, for example, the stage of their development.

The method of representing an agreement on joint and simultaneous satisfaction of rational interests of the RVS graphically may vary, but the best seems to be endowing bidirectional arcs (arcs must be bidirectional, since this is an agreement between two parties. In value networks, unidirectional arcs can be used, with the input vertex being the RVS, which is the value object of another RVS) with squares and rectangles, describing the degree of development and the nature of rational interests.

Table 1. Example of RVS_1 and RVS_2 expectations and behavior assessments

	RVS_{1e}	RVS_{1r}	RVS_{2e}	RVS_{2r}
RVS_1	1,0	0,8	-0,5	-0,7
RVS_2	0,7	0,9	0,3	0,5

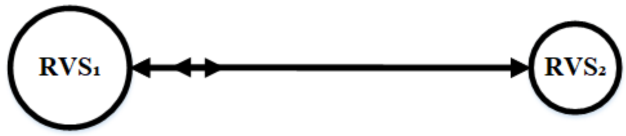

Figure 1. An example of modeling behavioral communication of the RVS

Behavioral communication has been described many times in scientific literature: RVS_1 influences RVS_2 in order to obtain this or that result. However, the following questions inevitably follow from such a formula: what is the result of the influence of one RVS on another? How does the influence occur? And, perhaps, the most important question: who influences whom, the RVS on the value object or the value object on the RVS?

Firstly, the result may or may not correspond to rational interests. Secondly, it may differ in its scope. Thirdly, it may be positively assessed by one RVS and negatively by another. Fourthly, the result may be expected or unexpected. The result is a consequence of the behavioral impact of the RVS on each other, but in this case, the complexity of modeling mutual influence arises. However, the complexity is not only in this: the result of the behavioral interaction of the RVS is dictated to a greater extent not so much by behavior as by the attitude, a special case of which is behavior. Let us narrow the interpretation of the rational-value attitude to a minimum, and it turns out that the RV-attitude in the behavioral aspect gives a result in the form of compliance or non-compliance of the behavior of RVS_2 with the expectations of RVS_1, therefore, the behavioral communication of the RVS includes an assessment of behavior.

The moral maxim of the RVS-relationship is as follows: if RVS_1 allows RVS_2 to evaluate its behavior, then it has the right to demand the opportunity to independently evaluate RVS_2's expectations. It follows from this that both RVS_1 and RVS_2 conduct four evaluations in behavioral communication: their own expectations and behavior, and the expectations and behavior of the other RVS. Let us assume that these evaluations look as follows (Table 1).

The average of one's own ratings can be displayed in the size of the vertices, while the average of the ratings of another RVS can be displayed as a duplicate of the arrow crossing the arc. The arc in this case is a rating scale from -1 to 1 in the direction of the other vertex. In this case, the behavioral communication of RVS_1 and RVS_2 can be depicted as follows (Fig. 1).

The article [Kondratenko, 2026] provides examples of analysis of various aspects of rational-value communication. In particular, these aspects were divided into blocks within the

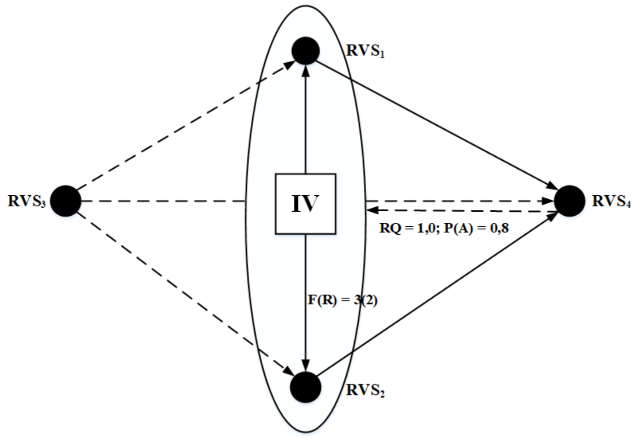

Figure 2. Graphic representation of the RVSs interaction network

Table 2. Example of a data window of the RVS interaction network

V-communication	
RVS_1	RVS_2
V = 0.3	V = 0.8
R = 3	R = 2
$R_V < R$	$R_V < R$
$R(RVS_1, RVS_2) = 3$	
$F_R(RVS_1, RVS_2) = 3(2)$	

RVS – value (V-communication), rational (R-communication) and behavioral (B-communication), – while specifying that these aspects are the position of the modeling block as the most neutral participant in the interaction of the RVS. The value aspect is associated with the analysis of the significance of communication (V), the average distance between systems (R), the desired distance (R_V) and the strength of the value connection (F_R), which is quite complex and can be visually modeled.

The rational aspect involves studying communication as a variant of the game that assumes a certain degree of readiness for the game (K_g – the readiness coefficient), the tension of interaction due to uncertainty (U), strategies analyzed using the analytic hierarchy process, as well as moves studied using game theory. The study of the behavioral aspect assumed the introduction of an independent observer who evaluates the behavioral characteristics of the systems (B) and the scale of the consensus space of interaction (S_{cons}). Since one of the key problems of the article was called the question of a single whole, the study touched upon the correspondence and similarity of the elements of the structure of the behavior of systems, and for this, the indicators of maximum risk (RQ) and maximum chance (P(A)) were required.

An example of visual modeling of rational-value communication and a data table are presented in Fig. 2 and Table 2.

R-communication
Criteria
1 – «power and control»
2 – «trust»
3 – «respect»
4 – «comfort»

		RVS_1 rating		RVS_2 rating		
Criteria	Sign.	«RVS_1»	«RVS_2»	«RVS_1»	«RVS_2»	Sign.
1	1	1	0	1	1	0.5
2	0.75	0	1	x	x	1
3	0.5	1	1	1	0	0.25
4	0.25	x	x	-1	1	0.75

RVS_1	RVS_2
K_g = 0.6	K_g = 0.857
U = 0.1	U = 0.4

RVS_1	1	2	3	4	5	6
1	1	5	3	3	5	1
2	1/5	1	1	7	3	1/3
3	1/3	1	1	3	3	1/7
4	1/3	1/7	1/3	1	1	1/9
5	1/5	1/3	1/3	1	1	1/5
6	1	3	7	9	5	1
«RVS_1»	1	2	3	4	5	6
1	1	3	1/5	3	7	1
2	1/3	1	1/3	3	1	1/3
3	5	3	1	5	3	3
4	1/3	1/3	1/5	1	1/3	1/5
5	1/7	1	1/3	3	1	1/3
6	1	3	1/3	5	3	1
RVS_2	1	2	3	4	5	6
1	1	1/3	3	5	5	1/3
2	3	1	5	7	5	1/3
3	1/3	1/5	1	1/3	1/5	1/7
4	1/5	1/7	3	1	1/3	1/9
5	1/5	1/5	5	3	1	1/5
6	3	3	7	9	5	1
«RVS_2»	1	2	3	4	5	6
1	1	1/5	1/3	5	1/7	3
2	5	1	5	7	3	5
3	3	1/5	1	3	1/3	1/3
4	1/5	1/7	1/3	1	1/5	1/5
5	7	1/3	3	5	1	5
6	1/3	1/5	3	5	1/5	1

RVS_1
0.2979; 0.1277; 0.1048; 0.0419; 0.0489; 0.3784
λ_{max} = 6.5186; I_{cons} = 0.1037; R_{cons} = 0.0836
«RVS_1»
0.1983; 0.0901; 0.3851; 0.0439; 0.0782; 0.2041
λ_{max} = 6.637; I_{cons} = 0.1274; R_{cons} = 0.1027
Av. RVS_1
0.2481; 0.1089; 0.245; 0.0429; 0.0636; 0.2913
RVS_2
0.1594; 0.2648; 0.0328; 0.0429; 0.0786; 0.4212
λ_{max} = 6.722; I_{cons} = 0.1444; R_{cons} = 0.1164
«RVS_2»
0.0524; 0.4232; 0.0871; 0.0306; 0.2695; 0.1368
λ_{max} = 6.8752; I_{cons} = 0.175; R_{cons} = 0.1411
Av. RVS_2
0.1059; 0.344; 0.0599; 0.0368; 0.174; 0.279

B-communication	
RVS_1	RVS_2
B = (1; 3)	B = (3; 1)
$S_{cons} = 2$	
Correspondence and similarity	
1 – «motives» 2 – «actions» 3 – «purposes»	

2.2 Network modeling options for rational-value interaction

2.2.1 *Egocentric networks*

The rational-value system has values and meanings, implying value relations, which can be divided into four types: "pure" value relation, value-rational relation, rational-value relation, and "pure" rational relation. Let us assume that each of the objects surrounding the RVS can be labeled as V, VR, RV, and R, and also designated in a different color for simplicity. Let us imagine an ideal state of the RVS, described by the equality of relations, and the RVS as an impartial judge of its own values. Such pluralism of value relations is, in some way, a natural state of the RVS.

In this state, the networks of value relations will have several semantic layers, the basic layer of which will be made up of values that are directly related to the RVS. Let us call them conditionally "ego-values". In addition to ego values, we will single out other rational and elementary systems in the second-level layer and designate it as the dialogic values layer. Dialogic values in their abstraction will form the layer of worldview values, which, in turn, form the picture of the world. Thus, the network of value relations has 4 layers of elements. The layers are interconnected, so we can recognize the principle of congruence in egocentric networks as valid.

For example, RVS cares about its own resources, so it will most likely recognize the importance of caring about its own resources by another RVS included in the dialogic values layer and will contribute to their increase. Based on observation of care for resources, RVS will most likely form an idea of the significance of care for resources as such, and, as a result, care for resources will enter the RVS's picture of the world as a given. The idea of what should be, in turn, becomes the basis of behavior (and of some values that appear only because the idea that they should be was formed in RVS).

However, from the point of view of the network egocentric map, the issue of primacy is not particularly important. A more significant issue, which can become a modeling problem, is the possible absence of values of one level or another in the chains of significant value series. Such "zero" values become not only the boundary of knowledge and self-knowledge, but also conceal the danger of the simultaneity of multiple interpretations, including those that contradict each other. However, "decoding" of "zero" values is, ultimately, the practical meaning of egocentric networks.

"Zero" values are the result of deformation of the egocentric network. Distortions of the pluralism of value relations arise from various sources, the first and most important of which is RVS itself. The rational block contributes to the establishment of equality not only between the components of the network, but also between the layers. Strengthening the role of one or another layer or component contributes to the weakening of other layers or components. Establishing the causes of deformation of the value network is the second practical meaning of egocentric modeling. It must be assumed that there are other ways of using egocentric networks, but we will focus on those that have already been voiced.

Thus, structurally, the network egocentric model is an oriented graph with a central vertex RVS and arcs diverging from it, stretching through intermediate vertices of the ego- and dialogue-clusters to the peripheral vertices of the worldview-cluster.

The egocentric network model provides a valuable opportunity for empirical research, allowing to analyze individual value hierarchies, deformations of value structures under the influence of external factors, and also to conduct psychological diagnostics based on the identification of meaningless needs ("zero" vertices). The range of application of this model in empirical research is quite wide: it is applicable in sociological surveys to determine cultural differences, in marketing to link consumer preferences with deep values, in political psychology to study the connection of personal values with political views, in education to correct value orientations of schoolchildren and students, in corporate culture to improve teamwork, in social media research to analyze the reflection of value layers of users and even in criminology to build value profiles of offenders in order to predict recidivism. This state of affairs makes this model a tool for interdisciplinary research aimed at understanding a person and his interaction with the world.

2.2.2 *Communication networks*

The article [Kondratenko, 2026] described in detail the basic principles of RVS communication modeling, but did not solve the most important problem of analyzing communication networks – the problem of combining roles. In the previous section, it was shown that RVS interacts with value, value-rational, rational-value, and rational objects. At the same time, RVS can be each of these objects for other RVS. In addition, rational systems of another type (non-RVS) can be present in the modeling, which in this model are capable of establishing only rational relations (R-systems). Finally, the model can contain elementary systems (E-systems) that are not capable of forming either value or rational connections.

One of the options for solving the problem of combining roles can be assigning value relations to arcs and describing RV communication using semantic networks ("RVS_1 considers RVS_2 to be its value object"). The positive side of this approach will be the identification of value objects and value relations, i.e. emphasizing the subjectivity of value relations, and at the same time a significant disadvantage will be the uncertainty of RVS themselves: indeed, who believes RVS RVS? The introduction of an independent observer will only weigh down the model, and the belief in oneself is now described by arcs, and not by the vertices themselves. This disadvantage can be eliminated by changing the definition of RVS: we will call RVS a system that builds value and rational communication, as well as their variants, i.e. the definition does not come from the structure, but the structure becomes clear as a result of contact. Other rational systems may also have the ability to build value communication, but do not do this, due to which the ability remains undefined. Elementary systems may also have the ability to build RV communication, but due to the fact that this does not happen, we conditionally called them a certain conditional element of the network, capable of acting as a value, rational, etc. object.

Self-reference, however, is a more complex problem. We could represent such self-reference as a loop with an assigned value, and this arc would be used to identify the RVS along with other arcs. But this raises the questions: is one arc sufficient to describe autocommunication [Christensen, 2016]? And is it necessary to equate loops and arcs? The answers to these questions follow from the previous reasoning: one loop is quite sufficient to describe autocommunication, since an arc denotes a holistic communicative relation, and not a separate communicative act. Theoretically, there could be two loops, but they would have to denote the same relation, otherwise we would be talking about dysfunction.

The loop of autocommunication is determined by a simple majority (or the average in the case of equality of values), while the vertex is determined by summing the arcs and calculating the vector of vertices. There are two ways of calculating the vector here. In the first case, we neglect the difference between value-rational and rational-value communication and obtain, for example, the following result: if, let us assume, three value communication arcs and one value-rational one emanate from the top, then we conclude that the rational and value communication abilities of RVS are activated in the ratio of 1:7 (this ratio indicates the weight of the rational and value blocks in the RVS structure). In the second case, we describe the activity of the value and rational blocks in the RVS structure with one formula. For example, the network diagram shows two value, two rational and one value-rational communication, or 2V+2R+VR. This formula indicates the nature of the communicative activity of RVS and can be used to analyze individual communicative acts from any of the vertices (for example, two communicative acts are identified as value-based and one as value-rational. Consequently, with a high degree of probability we expect rational acts to follow).

The communication network model based on the communication types (V, VR, RV, R) can be applied in empirical studies to analyze social networks, identifying the dominant communication types in comments and posts, as well as to study interpersonal relationships, determining the prevailing types of connections (value/rational) in families or friendship circles. In organizational communications, it allows assessing the interaction of employees, in political research - to analyze the speech of politicians, identifying the dominance of rational or value arguments. In addition, this model can be used in media studies and advertising to classify news and optimize messages, in the development of artificial intelligence for training chatbots to recognize communication types, as well as in conflictology to identify imbalances as causes of conflicts. In addition, this model can be applied in intercultural studies to compare communication networks in different cultures.

2.2.3 Converged networks

The first thing that should be mentioned in the study of convergent networks is the uncertainty of the result, since, on the one hand, we still have too vague an idea of the “whole” and, on the other hand, the intentions of the participants may not guarantee the result at all, since these intentions may differ significantly, meet with opposition and represent something third in their unification. In view of this, it is not so much the result itself that is modeled, but the impact of the R- and RV-systems on each other, symbolically depicting the purposeful movement of the systems towards a certain common goal through other systems. Finally, it is worth mentioning that the impact of systems on each other is a variant of the “game of agreement”: an external observer can completely deny the significance of the expected result, however, if the systems themselves consider this result to be a “whole” - then for them it is so.

The main problem of modeling the impact of R- and RV-systems on each other is the uncertainty of the results of even individual acts of influence: by influencing someone, the system influences itself, and vice versa, just as by influencing external systems, one or another system can influence internal systems, and vice versa. In addition, there are several stages of convergence, characterized by specific effects:

1. Pressure on other value models: communication clarifies the significance of the "single whole", which correlates with other value models and suppresses most of them;
2. Formation of a system of collective ideas about the "single whole": systems can distribute roles to achieve this goal in one form or another, for example, the role of "idea generator", "critic" and "archivist";
3. Development and implementation of a plan for achieving the "single whole": the plan is subordinated to the system of collective ideas, individual actions and transactions are subordinated to the plan.

We are more interested in the last stage of convergence, since the first two stages were described earlier in general terms [DeLanda, 2002]. It is worth noting that the subordination of activity to a plan in one model initially determines the inequality of participants: there are probably those who create the plan and those who implement it (on the graph, the vertices will have different degrees according to the plan and according to the plan execution), in addition, there is obviously an inequality of contributions to the result. Probably, all these contradictions arise, first of all, due to the competition of plans in the struggle for shares or transactions carried out by systems. Each plan implies a circle of objects of influence for achieving the goal of the plan, or $P(RVS_n) = \{RVS_{n+1}, RVS_{n+2}, ..., RS_n, RS_{n+1}, \ldots, E_n, E_{n+1}, \ldots\}$. The plan may be identical (or recognized by the systems as identical), but the objects of influence will in any case differ. In this case, we will limit the modeling of convergent networks to the image of plans and their superposition on each other. Combining private and general plans will show the "cloudiness" of the behavior of rational systems.

Let RVS_1, RVS_2, RVS_3, RVS_4 be systems that have a common plan for forming a "single whole" P_U (only RVS can participate in such an alliance, since we know that each of the systems has the value of a "single whole"). Next, suppose that PU determines the behavior of each of the systems as follows:

$P_U = \{(RVS_1, RVS_2), (RVS_1, RVS_3), (RVS_1, RVS_4), (RVS_2, RVS_3), (RVS_2, RVS_4), (RVS_3, RVS_2), (RVS_4, RVS_2)\}$

Next, suppose that RVS3 and RVS4 have their own private plans P_{RVS3}, P_{RVS4}, and RVS_2 and RVS_4 have a joint private plan $P_{RVS3,RVS4}$ (the "single whole" is the maximum union of the systems, smaller unions will be called private), and each of these plans also determines the behavior of the systems:

$P_{RVS2,RVS4}$ = {(RVS_2, RVS_1), (RVS_2, RVS_3), (RVS_2, RVS_4), (RVS_4, RVS_2), (RVS_4, RVS_3), (RVS_4, RVS_6), (RVS_4, RS_1)} P_{RVS3} = (RVS_1, RVS_4, E_2, E_3) P_{RVS4} = (RVS_2, RVS_3, RVS_5, RS_2, E_1)

RVS_1 is the coordinator of the plan to achieve the "single whole", which does not need influences from other systems and is probably its architect. In addition, it does not have private plans, but the absolute "purity" of RVS_1's behavior is hindered by the need to be distracted by the influencing actions of RVS_2 and RVS_3. It is also highly likely that the idea of the "single whole" in the given example is more speculative than practical, since the influences subordinated to the plan of the "single whole" do not go beyond the circle of executing vertices. RVS_2 and RVS_4 have an excess of "private" influencing connections over "general" ones, and they have united to implement a joint plan. In view of this, the possible strategies of the participants of the "single whole" alliance become clear: RVS_1 will probably look for opportunities to unite with RVS_3 to balance positions and further pressure RVS_2 and RVS_4 with the aim of breaking up their alliance and taking control of RVS_4's capabilities, i.e. attempts to transfer "private" resources for the benefit of the "common cause". RVS_4, apparently, is more inclined to implement "private" plans, therefore it will try to strengthen ties with the "doubting" systems RVS_2 and RVS_3, and further actions of the systems will probably be associated with competition for RVS_3, for its inclusion in the joint plan of P_{RVS2}, RVS_4 or further integration into P_U.

The stability of the "single whole" plan can be calculated in different ways, but each of them will be speculative without taking into account time costs and fixing intermediate results that are significant for the systems. For example, RVS1 spends 80% of its time implementing P_U, RVS_2 – 57%, RVS_3 – 55%, and RVS_4 – 28%. These percentages show the degree of significance of the "whole" plan for each of the systems or for all systems on average (55%). The vector can be further filled with data on resources and perceived results. However, this does not provide much in the study of competition between plans. Apparently, the rules of competition are as follows:

1. As a rule, plans of similar size compete.
2. Plans of different sizes can compete, increasing the number of plans or network relations.

Based on these simple rules, we can conclude that the number of impacts determined by plans P_U and $P_{RVS2,RVS4}$ is the same – 7, and the sum of the impacts of P_{RVS3} and P_{RVS4} even exceeds P_U. It follows that vector estimates are more suitable for assessing the current situation, and network estimates are more suitable for assessing the strategy. If at the moment the network shows no signs of crisis and operates in normal mode, then its prospects are not so bright: the plan for creating a "single whole" in the given example is under threat of expansion of private plans - three of the four systems are immersed in private plans, which are at least no less significant for them than P_U, in addition, there is a situation of double competition of P_U with P_{RVS2}, RVS_4 and P_{RVS3} + P_{RVS4}. In this example, only a significant change in the situation will be able to correct the position of the plan for creating a "single whole".

The convergent network model, which describes the processes of unification of various actors to achieve common goals, provides broad opportunities for empirical research in various fields. It can be used to analyze collective projects, studying the coordination of goals by participants, as well as to study political coalitions, corporate alliances and scientific collaborations, modeling company mergers and studying the unification of scientists around common hypotheses. The model is also applicable to social movements, education and city management, allowing to analyze strategies for engaging supporters, networks of students working on group assignments and the coordination of urban projects. In addition, it can be used in cybersecurity, ecology and gamification, modeling attacks by hacker groups, interaction of actors in sustainability projects and cooperation of players to achieve common goals.

2.2.4 *Causal networks*

Actor-network theory states that objects, or non-humans, have the property of being connected to subjects, or humans Latour [2005]. Rational systems theory deepens the interpretation of objects as mediators: first of all, elementary systems are mediators between the same rational or rational-value system. The point is that influencing the E-system is not meaningless: the RVS or R-system tries to satisfy a rational or value need in this way, i.e. the E-system is an intermediary between the need and its satisfaction by the RVS or R-system. The RVS or R-system can satisfy someone else's need by influencing the E-system. The network, therefore, must in one way or another reflect the needs and the nature of their satisfaction through specific transactions, the mediator of which is the E-system.

The chain, however, looks a little more complicated. The RVS is characterized by the presence of values that generate needs for the enrichment of these values. Values and needs push RVS to activity, i.e. to interaction with E-systems. Modeling, therefore, should reflect the hierarchical chain of RVS transactions: value, need, activity [Goldman, 1967]. The complexity of such a model is that, on the one hand, displaying the hierarchy will lead us to an egocentric network, and in this case, connecting two or more hierarchies will be problematic, on the other hand, a network graph without a hierarchy will disrupt the sequence of the chain, in which the next element is a consequence of the previous ones. However, this problem has a solution - to use cause-and-effect network analysis [Pearl, 1988, 2009; Ackermann and Alexander, 2016; Aledo *et al.*, 2021].

Modeling will include five layers connected by cause-and-effect relationships: RVS, their value models, needs, activity and E-systems, which are the object of RVS influence. Let us analyze this model. The first thing to pay attention to is the layer of value models, which can duplicate the cause, signaling egoistic motivation. But in a broad sense, there is nothing wrong with all RVS being copied in the value layer, being value models for themselves and other systems. It is much worse when the value copy of the RVS is not represented there, which will mean the isolation of the system and its possible fallout from the network (R-systems will not be represented in this model, since the inability to accurately establish the cause in this case will not mean its absence; all systems by default in the cause-and-effect network are RVS). The difficulty lies in the fact that, hypothetically, the value model of one RVS can include not only all the vertices of one chain, but the entire network as a whole. However, this does not mean that it is necessary to duplicate the network components in the value layer several times; perhaps it is more reasonable to indicate them once, on the one hand, so as not to overload the model, and, on the other, to emphasize some autonomy of the value models from RVS.

The model should emphasize the hierarchy of RVS value models (demonstration of the value system), but the network can show more - for example, the cumulative effect of the value network, which enhances RVS needs. The needs layer also contains a number of difficulties: firstly, abstract needs are meaningless in the model, and this leads to the multiplication of vertices and network overload, secondly, the gap with the base layer of the network increases, which leads to confusion of cause-and-effect relationships. These difficulties can be solved in the following ways: the abstractness of needs is removed by the network itself, since needs are connected with specific value vertices; as for the gap between the base layer and the needs layer, in this case this problem can be solved using an individual image of each chain.

Thus, cause-and-effect networks are subject to certain methods of analysis, on the one hand, of hierarchical networks and genealogies, on the other - cognitive maps, without being in their pure form either one or the other. It can also be noted that they generally fit into the logic of behavioral analysis, including cognitive filters and decision-making schemes, with the difference that filters and schemes in this model do not correct, but are direct causes of the impact of some systems on others.

The cause-and-effect graph can be transformed into a cognitive map with the difference that in this case the cause, activation and transformation are one and the same property: RVS activates values, values activate needs, etc. In this case, it is logical to use fuzzy cognitive maps [Kosko, 1986; Dickerson and Kosko, 1994] with the assignment of weights to the arcs to clarify the degree of activation. Such cognitive maps can contain arcs directed from consequences to vertices, which will mean the pressure of the desired consequence on the cause, and loops symbolizing the degree of self-sufficiency of the cause for the activation of a particular consequence. Both loops and inverse arcs can also be assigned weights.

The causal network model, which allows identifying interrelated factors and their influence on each other, provides a powerful tool for empirical research in a variety of fields. In political studies, its application can help identify the causes of protests, linking economic reforms with mass protests; in marketing, it can determine how advertising influences consumer behavior. In healthcare, the model allows analyzing factors leading to a healthy lifestyle; in clinical psychology, it can build networks for PTSD therapy. In economics, the model can be used to study crises; in social media studies, it can study how content evokes emotions and spreads. In education, the model can be of significant help in analyzing effective teaching methods; in criminology, it can reconstruct the causes of crime. With the help of the causal network model, ecologists can assess the impact of legislation on reducing CO_2 emissions; and AI and big data specialists can predict user behavior by creating personalized models.

3 Conclusion

At first glance, the self-limitation of the theory of rational systems seems obvious - it does not apply to irrational systems, but this is not so. The properties of rational systems do not apply to irrational systems, but they can be included in the theory as an object of influence, i.e. modeled using the cause-and-effect networks described in the article. There are many concepts of irrational systems that describe heat, light, decay and combination of chemical elements, etc., but these theories are not able to describe the world of rational systems, but the theory of rational systems is able to include all these concepts.

This article raises several important topics. The first concerns the unification of systems into a "single whole". "Single whole" as a concept is a logical paradox, since "single" implies "indivisible", while "whole" means "consisting of parts". This problem raises the question of the compatibility of parts within the framework of a holistic system. In the context of rational-value networks, this is expressed in the contradiction between the autonomy of individual RVS and their integration into a single structure. The methodology proposed in the article attempts to overcome this paradox through the principle of congruence, which ensures the compatibility of components without their absorption or simplification. In particular, cause-and-effect networks demonstrate that the whole arises not through mechanical unification, but through the consistency of interactions, where each system retains its semantic uniqueness.

Thus, the RVS methodology proposes to solve the paradox of the "single whole" not through the denial of the private, but through its harmonious inclusion in the network dynamics, which opens up new possibilities for modeling complex social processes. The second topic presented in the discussion is the problem of the correlation of RVS, or the problem of congruence: indeed, the structure of RVS should include properties congruent to the properties of other RVS and responsible for their "coupling". Finally, the third topic is related to the spectrum of modeling RV-communication: the article substantiates the principles of modeling egocentric, communicative, convergent and cause-and-effect networks that can be used depending on the research objectives.

Basic analysis of rational-value communication is an analysis from the position of the modeling block. It seems that this is the most objective way of studying communication of this kind due to the maximum possible removal of the "correction for subjectivity". However, this does not remove the corrections from the assessments provided by the modeling unit, but in the future it is necessary to take this into account and try to minimize the subjectivity of assessments, trying to avoid them whenever possible (this becomes possible, for example, in cause-and-effect networks, which for a number of reasons seem to be the most promising direction of research, both in the broad sense, i.e. being a rational model of rational communication, and in the narrow sense, including the components of the RCS and forming cause-and-effect chains from them).

Despite the significant potential of the proposed methodology, its application has a number of limitations. Firstly, limitations caused by the complexity and abstractness of modeling. The complexity of operationalizing the concept of rational-value systems in practice can hinder their unambiguous identification in real social processes. The methodology assumes a high degree of abstraction, which can lead to simplification of complex social phenomena. Secondly, limitations caused by the complexity of standardization of subjective and temporal variables. Taking into account subjective factors (for example, zero vertices) requires deep qualitative analysis, which is difficult to standardize. The methodology also weakly takes into account temporal dynamics, although social networks are constantly evolving. Thirdly, limitations caused by the topic of congruence. The principle of congruence is not always amenable to empirical verification in dynamic network interactions. In addition, modeling a single whole remains largely hypothetical, since in reality complete congruence of systems is extremely rare. Finally, fourthly, formal limitations. The methodology requires highly qualified researchers to interpret network models, and network modeling involves significant computing resources with an increase in the number of nodes and links, which limits its application and scalability of the approach. All the limitations described indicate directions for further development of the methodology.

The study conducted in this article is based on the idea of the computability of communication, which is fair, since the reasoning concerned rational systems. But it does not follow from this that the theory of rational systems throws irrational (super-rational) elements out of context - on the contrary, it tries to rationalize them. Such elements, acting in different guises, form different structures of rationality – and different systems accordingly. Further research will be related to other forms of rational systems – recursive-sensory, isomorphic indeterministic and rationally-indefinite.

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Authors' Contributions

Konstantin S. Kondratenko is the sole author of this manuscript. The author contributed to the conceptualization, methodology, and writing of this article.

Competing interests

The author declares he has no competing interests.

Availability of data and materials

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