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Creative Reasoning and Content-Genetic Logic

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Abstract:
In decision making quite often we face permanently changeable and potentially infinite databases when we cannot apply conventional algorithms for choosing a solution. A decision process on infinite databases (e.g. on a database containing a contradiction) is called troubleshooting. A decision on these databases is called creative reasoning. One of the first heuristic semi-logical means for creative decision making were proposed in the theory of inventive problem solving (TIPS) by Genrich Altshuller. In this paper, I show that his approach corresponds to the so-called content-generic logic established by Soviet philosophers as an alternative to mathematical logic. The main assumption of content-genetic logic is that we cannot reduce our thinking to a mathematical combination of signs or to a language as such and our thought is ever cyclic and reflexive so that it contains ever a history.
Keywords: Genrich Altshuller, troubleshooting, creative reasoning, content-genetic logic.

1. What is Creative Reasoning?

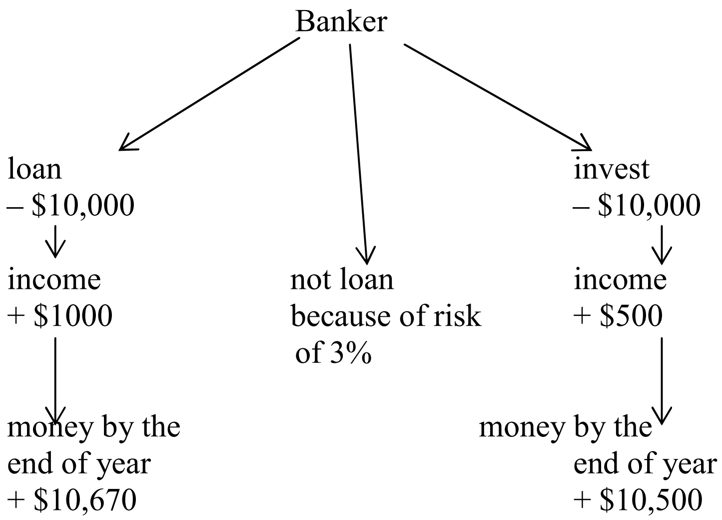
If somebody wants to have his or her own business, (s)he is forced to make a huge number of different decisions concerning assessment of professional and personal skills of his (her) workers and partners, management, business plan, financing, marketing strategy, location, customer service, etc. Thereby the situation is much harder that it seems at first sight, because decisions should be permanent: any business runs into problems, some of them are everyday and typical and others are unexpected and serious. In the first case we know which decisions are to be taken and how they refer to suitable intelligent tools. In the second case we absolutely do not. Decision making in the latter case is called *troubleshooting* and the agent of this decision is called a *troubleshooter*. Quite often a business analyst is invited to help managers in troubleshooting.

What do we mean by 'typical' problems? While precisely the same business-problems do not recur, if within our life-world we understand our business well, including its market, customers, and competition, we can make adequate permanent decisions concerning any area of our business that is currently in trouble. However, there are problems that cannot be solved with our background. They are untypical for us and we cannot explore solutions as usual. In this situation we can get a fresh perspective or invite a troubleshooter as outside consultant. If the problem really is out of our competence, we should look for a troubleshooter for assistance, e.g. if the problem is technical such as the following:

> Process plants operate about 28 days of the month to cover costs. The remaining days in the month they operate to make a profit. If the process is down for five days, then the company cannot cover costs and no profit has been made. Engineers must quickly and successfully solve any trouble when some problems that occur. Sometimes the problems occur during startup; sometimes, just after a maintenance turn-around; and sometimes unexpectedly during usual operation [13].

Nevertheless, there are situations that we can improve by our own means using just *creative reasoning*. Obviously, we can invite an outside troubleshooter in this case too, but it is important to learn how our solutions can work successfully. For instance, we wish to increase the product combination of furniture in our shop, but warehouse space is lacking. Then we should invent a method of individually supplying furniture for each concrete client. Or let us consider another example. Somebody is a political adviser who wishes to supply his client with a political promotion at the time when it is still or already prohibited. One more example from logistics: we wish to increase the volume of beverages being transported, having lowered thereby the transported volume in general. The idea of transportation of drink concentrate or its dry form became the creative solution.

Solutions, which we have already used, i.e. which have become a part of our habitus, are provided as conventional *data mining*. This means that we have some databases that are readily seen and clear for us and our solutions are prepared as logical reasoning on databases. Such data mining assumes inductive sets of data, namely data are regarded as a finite tree without cycles. For example, for financing a project a businessman needs to borrow \$10,000 for a one-year period. The bank can lend this money at 10% interest for one year or invest at 5% interest for one year. From experience the banker knows that 3% of such clients do not pay off the loan. The process of making decisions in the bank can be pictured as a finite tree without cycles. If the loan is given and repaid, then income is ((\$10,000 + 10% of \$10,000) – \$10,000) = \$1,000. If the loan is not given, but this sum is invested, then income is ((\$10,000 + 5% of \$10,000) – \$10,000) = \$500.



As the logical rule for decision making the banker can use the maximisation criterion (selecting a variant with a maximum income), then from two variants

1) giving the loan = (\$11,000 · 0.97) – \$10,000 = \$670;
2) not giving the loan = (\$10,500 · 1,0 – \$10,000) = \$500.

the banker infers the solution to give the loan. This decision making has the form of data mining in the way of creating the inductive tree, i.e. a finite tree without cycles.

Usually, data mining for typical problems is presented by constructing trees as inductive sets. The necessary requirements for sets in data mining to be inductive are as follows:

- Databases should consist of a finite number of members (items);
- All possible relations should be presented by a finite tree without cycles.

Nevertheless, there are cases where databases for our decision making contain some unsolvable oppositions that hinder the construction of inductive trees, e.g. in databases there is a contradiction that makes it ill-structured: our system should have a property *A* to fulfill a useful function, and it should have a property non-*A* to avoid a harmful function and we are not able to select either *A* or non-*A*. In turn, we cannot here use conventional data mining at all.

Let us consider some cases of unwanted oppositions in databases: (1) the item *A* has a useful effect on the item *B*, but permanently or at separate stages there is a harmful back effect; (2) a useful effect *A* is also accompanied by a harmful effect *B*; (3) a useful effect *A* on one part of *B* is accompanied by a harmful effect on its other part; (4) one useful effect is incompatible with another useful effect; (5) effect *A* on *B* is accompanied by a harmful effect on an environment or on the third object *C*; (6) due to an effect *A* there is a modification of *B* such that the third object *C* has a harmful effect on *A* or *B* or their environment, see for more details [3].

We know that conventional data mining may be regarded as the building of inductive trees. In mathematics this is understood as algorithm. Beyond all doubt, the most basic notion of mathematics and physics are presented by algorithm. It plays a significant role providing, e.g., a correct (from the standpoint of logic) reasoning in mathematics and a well-defined measurement by rigid scales in physics. Its simplest definition is as follows: *algorithm* is a set of instructions for solving a problem. In computer sciences, algorithm is regarded either as implemented by a computer program or simulated by a computer program. In other words, the algorithm is reduced to the computer's process instructions, telling the computer what specific steps and in what specific order to perform in order to carry out a specified task. Thus, any conventional data mining may be simulated by the computer's process instructions.

In business and other forms of our activity quite often we face permanently changeable and potentially infinite databases. For such databases we cannot successfully use conventional data mining by applying algorithms. Nevertheless, we know how to argue and make decisions only algorithmically, i.e. on a fixed database sketched as an inductive set. What we can do then? We can appeal to *creative reasoning,* a kind of interactive computing when we go out of our initial fixed database. Let us illustrate this property by the Bible story, when the Pharisees asked Jesus: ‘What thinkest thou? Is it lawful to give tribute unto Caesar, or not?’ (*Matthew* 25:17). Here it is supposed there are just two variants of answer: 1. ‘Yes,’ then the outcome of such an answer causes discontent among the Jewish people, 2. ‘No,’ then the outcome of such an answer causes discontent among the Romans. As a database for decision making there is an opposition between the Jews and Romans and an effect *A* (tribute) which is favourable to Romans and defective to the Jews. Actually, any solution concerning the effect *A* is impossible without essential losses (either for Romans, or for Jews). Jesus becomes a troubleshooter and offers the following creative reasoning: ‘Render therefore unto Caesar the things which are Caesar's; and unto God the things that are God's’ (*Matthew* 25:21). Due to this reasoning Jesus leaves the initial database and offers a co-database, where Jews and Romans can be combined without losses for each other. The initial database was significantly extended and as a result some inference rules of the initial database were rejected. Another example of a new logic with creative reasoning: let us take the database (the agents John and Mike promise to give each other only gift loans, the agent John can give money only with profit earning) and answer the question of how the agent Mike can receive money from

John. There are different variants which depend exclusively on our creative abilities, i.e on aour ability to be a troubleshooter.

Let us consider the history of the coronation of Charlemagne (Carolus Magus, Charles the Great). According to ritual, the Pope should crown Charlemagne emperor. In the database of decision making there were two items which cannot be rejected: (i) coronation was necessary for solidifying power, therefore it should be conducted according to the ritual; (ii) for political reasons it was inadmissible that the Pope crown Charlemagne as that would show that the Pope is above the emperor. Charlemagne found an original output: at the moment of coronation he snatched the crown from the Pope's hands and put it upon his head himself.

Creative reasoning is ever preferable to conventional. Let us remember the myth of the Golden Apple of Discord. Eris (Discordia), the goddess of chaos, strife and discord was not invited to the wedding of Peleus and Thetis, the future parents of Achilles. Eris took great offence and threw a golden apple to the guests with an inscription: 'To the Fairest.' In relation to its possession there was dispute among the goddesses Hera, Athena and Aphrodite, each of them considered herself the fairest. The goddesses appealed to Zeus. But even the Great Thunder, the king of all gods and people, did not have the courage to decide the dispute of women in such delicate problem and cowardly entrusted it to handsome Paris, the Prince of Troy. The goddesses immediately began to bribe Paris: Hera promised to give him power and riches, Athena wisdom and military glory, and Aphrodite offered him the love of the fairest woman. Paris gave the apple to Aphrodite. As we see, Paris followed only conventional reasoning and was not creative. As a result, the initial contradiction was not solved and concerned Paris himself: on the one hand, Aphrodite helped Paris to steal the beauty Helen, on the other hand, this led to the well-known ten-year Trojan war and the death of Paris' people.

If Paris were a troubleshooter like Jesus, he would have made a creative decision. For instance, (i) he could say: "All three of you are Fairest!" and eat the apple; (ii) throw two more apples with the same inscription; (iii) call for the court of Apollo, the patron of arts, to absolve him, as an outside troubleshooter, of any responsibility. However, Paris thought algorithmically, not unconventionally.

There are methods for the development of creative and troubleshooting imagination. A good troubleshooter should be able to uncover the problems which are tucked out of sight and unsuspected. The actual problem may be hidden and presented only by a symptom of a condition that requires sweeping change. A troubleshooter has to know how to overcome the inertness of thinking in the solution of creative tasks.

In order to look at the object in a new fashion, i.e. to see the properties and possibilities of the object, which are not marked earlier, and by that in a new fashion to formulate task conditions, the Soviet engineer and inventor, Genrich Altshuller, the creator of the theory of the solution of invention tasks, offered the following [2] – [6]:

1. Mentally reduce the size of the object from the given value to 0 and answer the question of how the task is then solved;

2. Mentally increase the size of the object from the given value ad infinitum and answer the question of how the task is then solved;

3. Mentally reduce the process time (or the velocity of object movement) from the given value to 0 and answer the question of how the task is then solved;

4. Mentally increase the process time (or the velocity of object movement) from the given value ad infinitum and answer the question of how the task is then solved;

5. Mentally reduce the costs of the object or process from the given value to 0 and answer the question of how the task is then solved;

6. Mentally increase the costs of the object or process from the given value ad infinitum and answer the question of how the task is then solved.

For example, in the artificial pollination of a peanut the air stream from the air blower should transfer blossom dusts. But plants in the course of evolution have obtained an ability to be closed at a strong wind. And the weak wind badly carries blossom dusts. How can we solve this contradiction? Mentally we reduce the process time from the given value to 0 and we notice that as a result we pass to the impulse pollination. Thanks to such breaking of stereotypes we come to a creative solution.

2. Content-Genetic Logic for Creative Reasoning

One of the first logical means for creative decision making were proposed in the theory of inventive problem solving (TIPS), in Russian: *teoriya resheniya izobretatelskikh zadatch* (TRIZ) which was developed by the Soviet inventor and science fiction author Genrich Altshuller (1926 – 1998) and his colleagues, beginning in 1946, see [1] – [6]. Altshuller notes that troubleshooting and creative decision making is aimed at avoiding first contradictions in databases. He claims that it can be done by means of a content-genetic logic created by him and called TIPS.

We know that troubleshooting is the process used to diagnose the problem (i.e. an appropriate contradiction in a database) safely and efficiently, to decide on corrective action and to prevent the contradiction in the system from reoccurring. Troubleshooting situations present symptoms showing where there is contradiction and should exhibit symptoms of deviations from the expected. Nevertheless, the symptoms may be misunderstood or might not reflect the real problem. According to Altshuller, the significant steps in defining a problem and in looking for creative decisions are as follows:

- Formulate the system's purpose, e.g. the main production (function) F of the system.
- Decide which main bodies participate (interact) in the system. For this purpose it is necessary to define 'basic functions' $f_1, f_2, ..., f_n$ (not less than two) and to add the function 'exterior circumstances.' Formulate 'supplying functions' $\varphi_1, \varphi_2, \ldots, \varphi_n$ (not less than two) for each basic one. Add an axis of 'undesirable effects' for each function of the system. Enumerate a maximal quantity of undesirable effects at this axis.
- Explicate the problem which should be eliminated. The problem can concern either f_i (basic function), or F (the system's purpose). Define, where there is an inconsistency between parts or properties of that system (called the looking for 'clashing pair'). Formulate the inconsistency.
- Explicate the parts of the clashing pair which can be changed, and which cannot be changed. For any part which can be changed, it is necessary to formulate two opposite states: antonyms. The component part, A, should have the property, B, for situation a and anti-B for situation b.
- According to the main assumption of TIPS, in that part of a system which is not useful to us, i.e. which is diagnosed by us as an inconsistency, there is also a resource for its improvement and the inconsistency solution. In other words, in the inconsistency there is a possibility of its removal. It is a decisive stage in creative decision making in accordance with TIPS.
- Solve the inconsistency by using methods of TIPS.
- Analyze solutions and evaluate them from the point of view of increasing the degree of system ideality. Generate a new (more ideal) concept of system functioning. Modify purpose F according to the system mission.

For the dialectical removal of inconsistency (Hegel's *Aufhebung*) in any system many methods are used in TIPS. The main methods are as follows:

1. *The "Crushing Method."* If the system has deleted resources of its development or the system functioning is impossible because of some limitations, it is necessary to crush the system. For example, in nature a lizard leaves its tail in case of danger, and an earthworm recovers his body if it is split into parts. The ability of plants to be multiplied simultaneously by seeds, leaves, shanks, and roots raises their survival rate. In shops increasing the number customers is linked to crushing the activity of shop employees into independent operations: contacts with clients, work in warehouse, cashiers, etc. Many small announcements for advertising may be better than one big announcement.

2. *The "Dynamism and Controllability Rise Method."* System features should vary in the way they can be managed at each stage. If the system is 'rigid,' not immobile, it is necessary to make it movable or changable. For example, hooved animals graze as herds, but at the appearance

of predators herds run in all directions. To draw attention to advertising in streets publicity boards with varying pictures (prism vision) are used or advertising on public transport is used as it is seen by many more people than stationary advertising.

3. *The "In Advance Method."* For instance, to avoid infectious diseases we get in advance inoculations from poliomyelitis, measles, etc., which protects a person from these diseases. For the magnification of effectiveness of selling goods we can advertise before the appearance of new goods and organise the pre-order system.

4. *The "Now and After Method."* This is exemplified by conducting one action during pauses of another action. We can then change the frequency of action. For example, for stable survival plants have different times for germinating seeds during different seasons. Presenting information in the form of running "ticker-tapes" for breaking news and headline summaries can be another example. To grow some plants like garlic or rye in Siberia, one sows these cultures in winter. Also, it may be a payment of goods on credit. This usually attracts additional clients.

5. *The "Integration Method."* If the system has reached a ceiling, it can be united with another system. It is possible to integrate, in particular, homogeneous systems or systems intended for similar operations. In nature there is a symbiosis for a mutual amplification of two sorts.

6. *The "Diversification Method."* If the system has deleted development resources or there are exterior limitations, then it is possible to develop one of its subsystems. So, viruses have developed the ability to use larger cells to receive new virus descendants.

7. *The "Copying Method."* Instead of the complex, expensive, inconvenient system it is possible to use its simplified and cheap copies (duplicates). For example, the sale of small 'trial' consignments of new goods may show the value of real preferences.

8. *The "On the Contrary Method."* Instead of action satisfying the task conditions it is possible to make a back relation. We can make a dynamic part of the system motionless, and a motionless part move. For example, in some big companies it is accepted as the rule that managers for some time work at lower positions.

According to TIPS, the methods mentioned above fix paths of dialectical development of any system (natural, social, technical). As a result of the given development, inconsistency is eliminated by itself, and the system moves into a more ideal level. We should see these paths and route the system development.

Hence, the logic of creative solutions, offered in TIPS, cannot be formal. It is a variety of the so-called *content-genetic logic*. The Soviet logicians proposed it, continuing some basic ideas of the German philosophers Kant and Hegel related to their logic with the highest evidence – *Transzendentallogik* of Kant and *Dialektik* of Hegel. This logic is essentially characterized by the following three features:

1. *Thought as a cycle identified with reflexion and reflexivity*, i.e. thought is a cognitive activity to have cycles in the course of which a person gives himself or herself an account of what (s)he was doing, and how, and (s)he becomes aware of all the schemas and rules by which (s)he acted. The sole task of content-genetic logic (e.g. *Transzendentallogik* of Kant and *Dialektik* of Hegel) is then to make simpler the ordering and classifying of the corresponding schemas and rules of our reflexion. Everybody has reflexion allowing us to make creative decisions and hence each of us is a troubleshooter from time to time. Therefore

> logic of the real basis for the forms and laws of thought proved to be only the aggregate historical process of the intellectual development of humanity understood in its universal and necessary aspects [i.e. in its reflexivity aspects—Sch. A.] [7].

2. While mathematical logic describes the inference rules (i.e. it understands thinking as a system of automatic inference), content-genetic logic understands *thinking as a permanent activity to be creative*, e.g. to invent something. This path to find out creative reasoning is called by the Soviet philosophers 'ascending from abstract to concrete' (the logic reflected in Marx's *Capital*). This permanent activity is initial and basic – it is a foundation of each social or psychological

activity. As a result, the genesis and evolution of thought, language, or inventions is examined as a revelation of schemas of content-genetic logic:

> The whole history of humanity was correspondingly also to be considered a process of the ‘outward revelation’ of the power of thought, as a process of the realization of man's ideas, concepts, notions, plans, intentions, and purposes, as a process of the embodying of logic, i.e. of the schemas to which men's purposive activity was subordinated [7].

Thus, logic has to be a *history of science* in the meaning of Thomas Kuhn [9], TIPS methods only fix the main historical forms of inventions.

> The subject matter of logic then proved to be those really universal forms and patterns within which the collective consciousness of humanity was realized. The course of its development, empirically realized as the history of science and technique, was also seen as that ‘whole’ to the interests of which all the individual's separate logical acts were subordinated [7].

3. The *thought-activity* studied in content-genetic logic cannot be totally algorithmized, but *may be partially technologized*. Therefore logic is understood as technical knowledge, but it is not considered a mathematical (deductive) knowledge. The schemas of that logic (e.g. schemas of TIPS) are not universal, they appear contextually within the concrete task or invention that the content-genetic logic is applied to.

> The subject matter of logic was no longer the abstract identical schemas that could be found in each individual consciousness, and common to each of them, but the history of science and technique collectively created by people, a process quite independent of the will and consciousness of the separate individuals although realized at each of its stages precisely in the conscious activity of individuals (…) It was merely a matter of this, that the schemas of cultivated thought (i.e. of the processes taking place in the consciousness of the individual) should coincide with those of the structure of the science in the movement of which the individual was involved, i.e. with the ‘logic’ dictated by its content. If the schema of the activity of a theoretician coincided with that of the development of his science, and the science was thus developed through his activity, Hegel would attest the logicality of his activity, i.e. the identity of his thinking with that impersonal, universal process which we also call the development of science [7].

In addition to Genrich Altshuller [3], the following Soviet scientists also had a significant influence on forming content-genetic logic: Ewald Ilyenkov [7], Aleksandr Zinoviev [14], Gregory Shchedrovitsky [11], and many others. Adepts of content-genetic logic agreed that their logic has to be regarded as a true method alternative to mathematical logic, i.e. as a science with the highest evidence in the way of German transcendental philosophy. According to the Soviet scientists, logic of creative reasoning cannot be reduced to formal rules of a language. Content-genetic logic is based on scientific results of Leo Wygocki (Lev Vygotsky) (1896 – 1934) who showed experimentally that thought is not developed in parallel with speech in the general case:

> The most important fact uncovered through the genetic study of thought and speech is that their relationship undergoes many changes. Progress in thought and progress in speech are not parallel. Their two growth curves cross and recross. They may straighten out and run side by side, even merge for a time, but they always diverge again. This applies to both phylogeny and ontogeny [12].

It follows from this that thought cannot be reduced to speech at all, that is human logic as a logic of creative reasoning cannot be reduced to a mathematical language. Therefore, this new logic called content-genetic logic has to be regarded as a study of the origins of knowledge (not as a study of ready-made knowledge by means of signs), i.e. it has to be considered a method in which the knowledge was obtained, because the method of knowledge construction affects the validity of that knowledge.

This idea shows the similarity between content-genetic logic and genetic epistemology, which was established by Jean Piaget (1968). The goal of genetic epistemology is to link the validity of knowledge to the model of its construction. But genetic epistemology, different from content-genetic logic, also assumes the use of the methods of formal logic:

> Genetic epistemology attempts to explain knowledge, and in particular scientific knowledge, on the basis of its history, its sociogenesis, and especially the psychological origins of the notions and operations upon which it is based. These notions and operations are drawn in large part from common sense, so that their origins can shed light on their significance as knowledge of a somewhat higher level. But genetic epistemology also takes into account, wherever possible, formalization – in particular, logical formalizations applied to equilibrated thought structures and in certain cases to transformations from one level to another in the development of thought [10].

In symbolic logic, we directly identify thought with linguistic activity and logic with the analysis of language. According to the Soviet (and now post-Soviet) tradition of content-genetic logic, language (speech) is, nevertheless, not the sole empirically observed form in which human thought manifests itself, there is also an example of behavioral activity:

> But, that being so, man's actions, and so too the results of his actions, the things created by them, not only could, but must, be considered manifestations of his thought, as acts of the objectifying of his ideas, thoughts, plans, and conscious intentions [7].

Self-development is an important ability of human thought that is reflected in studying creative reasoning by content-genetic logic:

> The development of modern science is characterized not only by an unusually rapid accumulation of new knowledge but also by the fact that the principles and methods of scientific research have essentially changed and are continuing to change [11].

Thus, content-genetic logic was made as an alternative to analytic philosophy. The two main properties of *content-genetic logic* are (i) the *locality and limitedness of any science* and (ii) the *historical contextuality of scientific thinking*. On the other hand, the two main properties of *mathematical logic* are (i) the *interdisciplinarity of scientific research* and (ii) the *universality of scientific thinking*.

In accordance with the two properties of content-genetic logic, Altshuller's TIPS has no general algorithms for creative reasoning. It deals with contextual schemas that were detected in the development of natural systems (organisms, animal populations, etc.) or in the evolution of social systems (firms, corporations). In Altshuller's opinion, there cannot be symbolic logic of creative decision making at all, just content-genetic logic.

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