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Original Article

THE CONCEPT OF USING EVOLUTIONARY ALGORITHMS AS TOOLS FOR OPTIMAL PLANNING OF MULTIMODAL COMPOSITION IN THE DIDACTIC TEXTS

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ABSTRACT

At the beginning we would like to provide a short description of the new theory of learning in the digital age called connectivism. It is the integration of principles explored by the following theories: chaos, network, complexity and self-organization. Next, we describe in short new visual solutions for the teaching of writing so called multimodal literacy 5–11. We define and describe the following notions: multimodal text and original theory so called NOS (non-optimum systems methodology) as a basis for new methods of visual solutions at the classes and audiovisual texts applications. Especially, we would like to emphasize the tremendous usefulness of evolutionary algorithms VEGA and NSGA as tools for optimal planning of multimodal composition in teaching texts. Finally, we give some examples of didactic texts for classrooms, which provide a deep insight into learning skills and tasks needed in the Internet age.

Keywords: algorithm, didactic text, connectivism.

DESCRIPTION OF CONNECTIVISM

Connectivism is a learning theory for the digital age. Learning has changed over the last several decades. The theories of behaviourism, cognitivism, and constructivism provide an effect view of learning in many environments. They fall short, however, when learning moves into informal, networked, technology-enabled arena.

The integration of cognition and emotions in meaning-making is important. Thinking and emotions influence each other. A theory of learning that only considers one dimension excludes a large part of how learning happens.

Learning has an end goal – namely the increased ability to "do something". This increased competence might be in a practical sense (i.e. developing the ability to use a new software tool or learning how to skate) or in the ability to function more effectively in a knowledge era (self-awareness, personal information management, etc.). The "whole of learning" is not only gaining skill and understanding – actuation is a needed element. Principles of motivation and rapid decision making often determine whether or not a learner will actuate known principles.

Learning is a process of connecting specialized nodes or information sources. A learner can exponentially improve their own learning by plugging into the existing network. Learning may reside in non-human appliances. Learning (in the sense that something is known, but not necessarily actuated) can rest in a community, a network, or a database. The capacity to know more is more critical that what is currently known. Knowing where to find information is more important than knowing information. Nurturing and maintaining connections is needed to facilitate learning. Connection making provides far greater returns on effort than simply seeking to understand a single concept.

Learning and knowledge rest in diversity of opinions. Learning happens in many different ways. Courses, email, communities, conversations, web search, email lists, reading blogs, etc. Courses are not a primary conduit for learning. Different approaches and personal skills are needed to learn effectively in today's society. For example, the ability to see connections between fields, ideas, and concepts is a core skill.

Organizational and personal learning are integrated tasks. Personal knowledge is comprised of a network, which feeds into organizations and institutions, which in turn feed back into the network and continue to provide learning for the individual. Connectivism attempts to provide an understanding of how both learners and organizations learn. Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning.

Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate impacting the decision.

Learning is a knowledge creation process... not only knowledge consumption. Learning tools and design methodologies should seek to capitalize on this trait of learning [1].

MULTIMODAL TEXT PARADIGMS FOR CONTEMPORARY EDUCATION

In order to be able to talk about paradigms using multimodal text in the education process much of the term should be explained. The paradigm according to key terms is a philosophy of science, which tries to explain the essence of existence and create the foundations of research programs. The paradigm includes traditional forms of research and the combination of ontology and epistemology, their perspectives and ways of knowing forms of knowledge.

A paradigm is a commitment to cultural practices, reality shows and knowledge. Many of the assumptions, conventions and practices prevailing in a culture are taken for granted, but sometimes they are not understood by other cultures. Furthermore, it is a combination of logic, philosophy of science and research. One of the first who gave meaning to that word today was Thomas Kuhn who defines it as a description of what is to be tested and observed and how to ask questions to get answers.

What are multimodal texts?

In everyday print-based communications like newspapers, mobile phones, TV, words are almost always accompanied by photographs, diagrams or drawings. However, screens are much more familiar not only in the school, but in shops, workplaces and homes. Many everyday texts are now multimodal: combining words as well as sound with mowing images, color and a range of photographic, drawn or digitally created visuals. People of all cultures have always used a range of ways to represent own ideas. In the contemporary 'digital era' the 'newness' is the way that messages are relayed and distributed thorough different media of communication. Even the most familiar and everyday communications are made up of complex combinations of modes. A conversation, whether in face-to-face meetings or viewed on screen is accompanied by movements and gestures; print is often accompanied by pictures; and films and television programs rely on

Table 1. Comparing Systems Theory and Connectivism [1]

Systems Theory	Connectivism
• describes concept formation and mental process in functionalist (goal-driven) ways	• associationist theory; describes how connections are formed
• consequentialist/causal process theory • knowledge is formed through a combination of simple mechanisms	• emergentist theory • knowledge formed by such a system has an impact by virtue of recognition (hence, interaction)
	• distributive theory • concepts have no particular location • no discrete existence (in the mind or elsewhere) • distended across a large number of entities (e.g., neurons) • have fuzzy boundaries • are intermixed with other (distended) concepts and ideas

sound effects and music to add atmosphere and effect. Any multimodal texts might combine elements of:

- gesture, movement, posture, facial expression
- images: moving and still, real or drawn
- sound: spoken words, sound effects and music
- writing, including font and typography.

These elements will be differently weighted in any combination of modes. Children and all people living and grow up in a highly multimodal environment. They are surrounded by texts on screen and on paper which merge pictures, words and sounds. They expect to read images as well as print and, increasingly use computers in seeking information and composing their own texts. This has implications for teaching. The texts that children are familiar with- including computer games and hypertexts- often follow a different structure from sequential narrative, instruction or explanation. Presentational software and websites extend possibilities for hypertextual compositions, and digital technology, with its facility for importing pictures and manipulating text [2].

EVOLUTIONARY ALGORITHMS – SHORT INTRODUCTION

The dynamic development of information technology has caused a great interest in science in the field of artificial intelligence, evolutionary algorithms, genetic or artificial immune systems. Currently the above mentioned scientific disciplines are used in various fields of science and education. For solving technical or engineering tasks the Darwinian theory of evolution is almost universally used Evolutionary algorithms are used in many fields of science, for example in issues typically for engineering, economic, and even investment [3]. Evolutionary algorithms are a group of heuristic methods and optimization, which in its action mimic living organisms. Now we can identify some groups of genetic algorithms, for example:

- Genetic Algorithm *J. Holland in 1975*,
- Evolution Strategy *I. Rechenberg 1973, H. P. Schwefel 1981*
- Evolutionary Programming *L. Fogel 1962*
- Genetic Programming *J. Koza (1992)* [4].

The task of the evolutionary algorithm is to search space of alternatives to select the best or potentially best solution. This search is done by using the mechanisms of evolution and natural selection. The principle of operation of an evolutionary algorithm is based on processing population of individuals, each of which is a proposal to solve a particular task. Each subject is assigned with a value, referred to the adaptation of the subject, moreover, is equipped with a genotype, which is created on the basis of phenotype [5]. The most popular evolutionary algorithms include: algorithm VEGA, NSGA, or swarms of ant colony optimization. The figure below shows a diagram of the evolutionary algorithm according to Eiben and Smith.

An example of using the evolutionary algorithm is an optimization of the schedule for the University. The principle of the algorithm is based on the allocation of rooms and dates of classes in such a way to adjust the time limits for speakers, without unnecessary collisions (rooms or personal) while minimizing discontinuities time in the schedule (free time) [7].

Simulations

At the Technical Universities, students are faced with difficult and complex computational tasks but more efficient and cheaper can be designing an algorithm that simulates arbitrarily

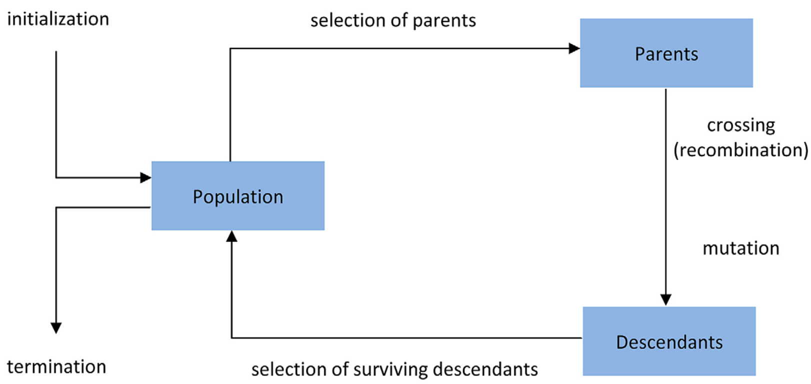

Fig. 1. Schematic of the evolutionary algorithm [6]

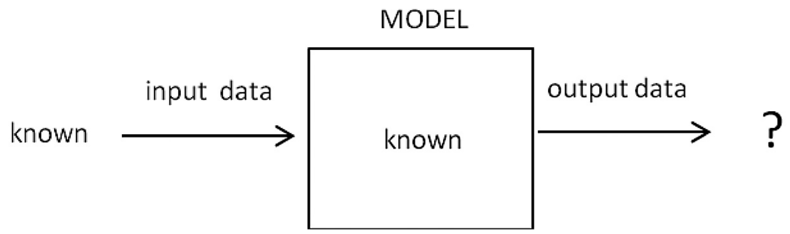

Fig. 2. Diagram of simulation problems [7]

large electrical system to build it in order to investigate and verify its properties.

The simulations rely on generating the output when given input data and model control.

The main advantage of the evolutionary algorithms is not intuitive. The human brain tries to look for solutions in purely schematic, using traditional solutions. In the case of the evolutionary algorithms optimization tasks are not restricted and search solutions in order to select the best or potentially best.

Modeling

In this case sought model describes how the system generates the selected input data to the known output.

Using the above mentioned model we can construct models of certain machines or robots which would perform their tasks. It should be borne in mind when constructing or modeling the function fitted to the data. The input is then independent and output dependent, model -function. The evolutionary algorithms can be used to create zooming function data, which then will serve us as a model. One of the main advantages of the evolutionary algorithms is the lack of ordinary skill enjoyed by a teacher or an expert, in the case of directed evolution algorithms is the choice of the most appropriate function. The mere fact of modeling is done using specific data, without the knowledge of the outside.

The evolutionary algorithms are widely used and are increasingly used in different areas of science and education. They shorten the maximum time and the calculation of complex engineering tasks while minimizing the computational cost and implementation. Moreover, they are often used in the design of various projects in education, for example, when teaching science education, where teaching materials require great knowledge on performing a series of complex calculations. In the evolutionary algorithms for optimization tasks semantic web, organize collections are also met, in the case of the optimization schedule or optimal planning of multimodal texts teaching composition and personalization of information resources on the Internet. The above presented examples of the use of the evolutionary algorithms in addition to the purely computational issues also include such aspects of life as: transportation, management and marketing, scheduling working hours and production.

The concept of using the evolutionary algorithms as tools for optimal planning of multimodal composition in the texts of teaching.

In the case of the development of multimodal composition of didactic texts, we try to use versatility of the evolutionary algorithms. A similar principle of operation can be found at the penetration of the Internet as a source of knowledge and education. Artificial immune systems are moving in the environment, like Internet users move along its resources. Reach their interest of knowledge or information. Taking into account the technical aspects of the Internet or any other group of materials or composition will have to make a few preliminary steps, such as user identification, segmentation and identification of the session. In the case of a cer-

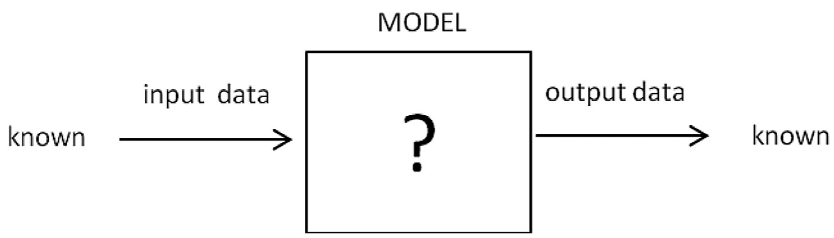

Fig. 3. Schema of modeling problems [7]

tain specificity of which is the graph of resources that have forced us to change in the operation of the algorithm. In the case of the use of the evolutionary algorithms, we can get satisfactory results, which will take into account data from the second part, important for teachers', which in traditional terms may not be taken into account. By creating certain resources or compositions we may try to use the hints that the algorithm suggested bearing in mind that this is an attempt to optimize its assumptions. In the case of solving similar problems of optimization is the most important selection of some of the parameters and rules of the algorithm, not without significance is the way to represent the environment that are to explore artificial immune systems [8].

NEW APPROACH – HIGHER EDUCATION AS FUZZY NON-OPTIMUM SYSTEM

The theory of non-balanced self-organized system, starting from the study of the balanced-open system which the objective world proper possesses, reflects truly the whole internal mechanism and the common principle of the ordered and functional ordered structure in various time-space.

According to the self-organized system principle, an ordered system may go into confusion, and naturally, it is very important to study the reasons, ways and consequence of the ordered system going into confusion. If an ordered system going into confusion is necessary for us, we have to control its speed, so that it may be more fit for our needs; if it is harmful for us, we have to take some measures to prevent it from going into confusion, and manage to make it more ordered. The higher degree of development is the systematic optimization. That is the purpose of studying this system. So the lower degree is the non-optimization. According to the theory of "dissipation structure", as long as the system is open, the non-balanced state may become the source of ordered system. So the non-optimum system is the basis of the optimum. Only when the system goes out of the non-optimum category, can it come into the stage, where we are to seek optimization. The first concept of the optimization was only judged by a comparison with one another and now the concept of the optimization is searching for the very big and very small of the objective function under a certain control. But actually, the optimization project or system which best represents the objective function bears only relative significance, that is, they are realized under a certain and strict condition. The optimization project or system which best represents the objective function bears only relative significance, that is, they are realized under a certain and strict condition. Because of the complication of mans, social practice (many undetermined and uncertain factors, alternation and the influence by his behaviors) and the feasibility of the pursued goal in present circumstances.

So the traditional optimum methods have their problems which must be analyzed and solved with all dimensions considered. Our purpose is to develop a concept of relative optimum (RO) and thres-optimum hold (OT), with the RO including the "non-optimum" (NO), "sub-optimum" (SO) and the "optimum" (O), following the theory of unity of the opposites. Thus the human practice processes and results are divided, according to their nature, into O, SO and NO sections. From these three directions we can best study the features and rules of system optimization [9].

The types and models in the NOS (Non-optimum System)

In the previous considerations we discussed the relationship between the system no-optimum and the optimum. However, since all systems are sub-optimum in their nature, our aim is set on the problem of system's optimization and non-optimum. Analyzing the general laws behind the systems' movement, we can sum up three different non-optimum (NO) types:

1) Systems formed from the changed states of the systems' old self in the process of system movement.
2) Systems formed because of changes in constraint factors and new constraints can no longer satisfy the operation of the systems.
3) Systems formed from changes in both the system's own states and their constraints, operating in new conditions and thus making it impossible to determine their laws. Then the systems move in the NO category.

Judging these NO system phenomena, we can see that (1) some have obvious NO conditions and can be identified from observation and analysis of the past operations of the system; (2) others are fuzzy NO; people can identify them according to the intrinsic fuzziness of human experiences and reasonings in a system with fuzzy information. They are sets or "grey NO (non-optimum)" and valuable for system operation decision-making and management; (3) potential NO: hidden in the forming stage in a system, has defects in its design but not effecting to functions within certain conditions and its information has not been sensitized.

One rule of scientific research is to develop from the analysis to the quantitative qualitative. To the NOS (non-optimum system), if we discuss at certain level of the understanding of its intension. we can analyze quantitatively.

Suppose the degree of the NO of the system to be n (NO parameter) which is the degree of satisfaction that the system's constraints are given by each factor of the system. This is a typical systematic optimization problem. According to the conventional methods for optimization, it is a process of minimizing the target function while satisfying.

To a NOS can set a value of optimum level which is the optimum threshold determined by the system and statisticalized and processed. If this value equals 1 then the SON (system optimization) accords with the reality, if value is 0 the SO doesn't accord with reality, that is, the system is not optimized. If value of this parameter is between 0 and 1 then the SON is called satisfactory optimum. For example 0.5 means the system is in a sub-optimum (SO) state; if 0.7, then the system is at the 0.7 optimum level.

Because the process of SON is cyclic, the system will, after a cycle, get a group of NO degree values which make up the O threshold, and NO threshold that is A and A no.

If we can evaluate all the NO parameters of the system, that is, get the O threshold and NO threshold, then we can control the operation of the system and keep it off the NO threshold, thus gaining satisfactory O target.

If the system is clearly NO with clear information, then it can definitely be called as "generally NO".

1) Common probability model. It is a basic NO system model structured from the values of NO parameters with a certain logic relationships The system calculated and discussed by them all belong to the narrow-sensed NO. The methods used for predicting the NOS parameters include those of mathematic calculation, Monte Carlo methods, limit line methods and Boolean logic methods.
2) Regressive model of NOS. Suppose there are P number of constraints whose variables are x_1, x_2, …, x_p, that shape a NOS from which each constraint and linear interrelating divisors of state variables and constant divisors can be analyzed. Then based on the appearing probability of as few as possible typical constraints x_1, x_2, …, $x_{n,}$ we can predict the level and probability of the NO phenomenon.

So the degree of satisfaction of the constraint conditions determines the reciprocal conversions of the NO and O (optimum) of the system and differentiate the various level system optimization [9].

The practical implications of the NOS methods

According to the self-organizing principle of the systematology. The development of human society is forever in the dynamic process of moving from the less ordered toward the more ordered larger system, or toward it destination point cycle.

However we must be aware of the hidden danger under the vigorous reform stream which may bring about mistakes and failures. Meanwhile we have already suffered a few mistakes and setbacks in some areas to some extent. What is more serious is that some mistakes and setbacks suffered have been repeated and what could be avoided was not.

Even if some model is considered optimum under the present circumstances, it is hard to be a stable one because it is in the midst of a dynamic process with quite a few hidden threats lurching and many horizontal or vertical relations between factors and their specific laws unknown. The so-called optimum model is only at a SO state. So, if we try to set goals for the reform, make plans and take measures and advocate some optimum models simply following the optimum thinking methods out of blind subjective wish, we'll be actually putting the reform on an unreliable and unrealistic basis.

Applying the principle of multiple perspectives of the university can be viewed from different points of view. From the government's point of view the university can be seen as an optimal system (curriculum), while from the student's point of view is important to their experience (hidden curriculum). Based on this experience, we can develop a non-optimal system [10]. This can be seen to be extremely useful NOS systems.

We can also see the education in terms of historical development as a developing system. As we have said, a system that is optimum in one time and space environment may be non-optimum in another. The behavior of a system is almost circling around the cycle from the unbalanced state to the balanced from the disordered to the ordered, overcoming “ups and downs” and “disruptions” to reach its “destination point” or “destination ring” in its reciprocal space. So the non-optimum cases under different conditions are different.

CONCLUSIONS

1. Connectivism is a learning theory for the digital age. Learning has changed over the last several decades. The theories of behaviourism, cognitivism, and constructivism provide an effect view of learning in many environments but not for ‘new digital age’.
2. In everyday print-based communications like newspapers, mobile phones, TV, words are almost always accompanied by photographs, diagrams or drawings. However screens are much more familiar not only in the school, but in shops, workplaces and homes.
3. Evolutionary algorithms VEGA and NSGA as a tools for optimal planning of multimodal composition in teaching texts.
4. Applying the principle of multiple perspectives of the university can be viewed from different points of view. From the government point of view of the university can be seen as the optimal system (curriculum), while from the student’s point of view is important to their experience (hidden curriculum). Based on this experience, we can develop a non-optimal system [10]. This can be seen to be extremely useful NOS systems.

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