PROGRESSIVE ARTIFICIAL NEURAL NETWORK FOR MEDICAL APPLICATIONS

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Introduction

Inventions in medicine

Since antiquity, there have been many inventions in the medical field, such as surgical instruments, the use of various kinds of medical procedures (massage, acupuncture, steam therapy, etc.), substances that have a therapeutic effect, etc. All inventions in medicine, as well as in other fields, were made due to the talents of individuals and the use of the Trial-and-Error method.

Genrich Altshuller began developing the Theory of Inventive Problem Solving (TRIZ) in the middle of the 20th century, [1, 2], based on the laws and patterns of evolution and the possibility of their application to create inventions, including eliminating shortcomings, increasing the use of existing systems and forming fundamentally new systems to perform useful functions. At the beginning of the development of TRIZ, the first examples of its successful application in the medical field appeared (A.Yu. Likhachev, A.B.Selyutsky, B.S.Farber, G.A.Kogan, etc.).

Since 1994, TRIZ masters Vladimir Proseanic and Boris Zlotin's company "Ideation International Inc." has participated in more than 20 large inventive projects at medical companies and centers in the USA, Israel, the Netherlands, and Kuwait. V. Proseanic, TRIZ Specialist, CEO of "Progress, INC.", "Omega Server, INC". B. Zlotin, TRIZ Master, Chief Scientist of "Progress, Inc." and "Ideation International Inc.

In particular, projects have been carried out with the companies "Covidien" (Medtronic), Johnson & Johnson, Ethicon, Merck, Baxter International Inc., Cardiovascular Medical Devices, Wartner Trading B.V. (Netherlands), "Hanita" (Israel), and several other startups in the medical field. A significant part of this work included the solution of medical scientific problems using the "methodology for solving scientific problems" based on TRIZ [3, 4]. In addition, V. Proseanic and B. Zlotin actively cooperated, in the field of medicine with "Rays University," "Kreighton University," "Vanderbilt University," "University of Western Ontario" and "Bar-Ilan University." They also were instrumental in patenting more than 20 medical patents and provided a "technical circumvention" of several medical patents that were interfering with customers' projects.

Boris Farber is a TRIZ Master, Doctor of Science in Mathematical and Computer Modeling in Biological and Medical Systems, and PHD in Biotechnical and Medical Devices and Systems Design. As Science Director of the Central Research Institute of Prosthetics and Prosthetic Development and CEO of numerous corporations, Dr. Farber together with Dr. Artur Martynov and his colleagues have applied extensive Mathematical Modeling and TRIZ in various fields of medicine and related areas since the seventies. The various R&D projects implemented by him and his colleagues can be combined in groups: Bioengineering; AI, including Creation of AI Expert systems for Bioengineering; repurposing generic drugs by synergetic design with unique properties; Novel generation of dynamic self-organizing drugs; Supramolecular nanostructures, Silico Modelling and Multiple ligands docking, Methods of therapy and Diagnostics [5, 6].

Artificial Intelligence (AI) in medicine

From the early development of computer technologies, the effective application of AI in medicine began. The development of various medical sensors, devices for examining internal organs and general diagnostics, the improvement of medical instruments and the control of medical procedures, and more recently the appearance of robots performing surgical procedures are some of the areas of innovation contributed by computers. However, the introduction of artificial intelligence (AI) into medicine was much less successful.

In the early 1970s, great success was expected all over the world from the creation of a type of software "expert systems." It was believed that the accumulation of the experience of many specialists and their transformation into some "rational rules" with the help of special programming languages such as, "Prologue" and "Lisp," would be able to provide effective diagnoses of diseases and the optimal choice of drugs and treatment protocols.

One of the first was the MYCIN expert system for diagnosing bacteria that caused severe infections, followed by many other expert medical systems created in different countries. For example, in the aforementioned Central Research Institute of Prosthetics and Prosthetic Development Science, which was led by Dr. Boris Farber, an expert system was created for the application of Bioengineering for prosthetic and orthopedic devices. This system took into account the study and analysis of the biomechanics of each patient individually, which was applied to the practice in two medical institutes.

However, there were not many examples where expert systems were widely implemented successfully, which could be explained by a few main reasons:
• Insufficient performance and speed for computing a large amount of data in the past. Even nowadays these

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characteristics are still insufficient, despite the rapid progress of computer systems.

• High complexity and nonlinearity of biological processes, which was an obstacle to build adequate models in linear programming languages.

The new hope for medical AI is the use of neural networks that can learn based on the training received to analyze deeply nonlinear complex systems. The first representatives of such AI initiatives were the IBM Watson systems, followed by Google's DeepMind Health project, projects by Medtronic, Pathway Genomics, and others. However, all of these were extremely costly projects, in the billions of dollars, that only large institutions could afford. Theoretically, neural networks are just as capable of simulating the intuitive conclusions of an experienced doctor – diagnostician. The classical neural networks used to this day, despite many attempts and some partial successes, have not been able to prove their effectiveness and remain unsuitable for widespread use. The lack of their effectiveness can be attributed to the following factors:

- Lack of a theoretical model of neural network operation and lack of transparency in their design and training.
- Excessive cost and low availability of computer equipment necessary for building powerful medical systems.
- The impossibility, even with the help of supercomputers, to process the necessary gigantic streams of medical information from large populations.
- Slow learning and the instability, unreliability and incomprehensibility of the operation of neural networks with a high risk of errors.

Another main reason for this is that all existing neural networks are based on the "load of old mistakes" - an extremely unfortunate configuration and method of training the first neural network - the perceptron, created by F. Rosenblatt. [7]

These errors arose from the fact that Rosenblatt built the perceptron as a model of the human brain, based on the biological doctrines of Dale and Hebb, which, as it turned out later, were fundamentally wrong. Because of this, the perceptron model has backward thinking rather than adaptability and foresight. It is the erroneous design of the perceptron and the associated training system that resulted, after over 70 years of development, in the realization that it was not possible to create Artificial Intelligence because of the prohibitive cost and time of developing and training networks [8]

The problems of modern networks were acutely demonstrated by the pandemic - numerous attempts to use neural networks have shown their complete unsuitability for real use.

This statement is especially supported by the publication in October of this year in the IEEE Spectrum magazine, October 2021 A SPECIAL REPORT: The Great AI Reckoning. Why Is AI So Dumb? [9].

The Solution:

Progressive Artificial Neural Network (PANN) is a fundamentally new type of neural network that differs from classical neural networks in greater proximity to natural neurons and methods of training them. In particular:

• PANN, unlike classical networks and contrary to Dale's doctrine, has more than one "synaptic weight" at each synapse (similar to natural neurons).

• PANN, unlike classical networks and contrary to Hebb's doctrine, does not use the gradient descent method in training (similar to natural neural networks).

Therefore, the PANN network avoids both of Rosenblatt's critical mistakes based on the doctrines of Dale and Hebb. At its core, PANN is an "improved version" of the universal classic perceptron, devoid of the fatal mistakes of its predecessor. Most importantly, PANN creates new opportunities, in particular:

• “Smart products” (including medical) based on PANN can be developed by medium and small companies, and even individual specialists, based on their experience and knowledge, at a speed dozens of times faster and at a cost that is thousands of times less than the classic neural networks of giant companies and institutions.

• PANN provides the possibility of constant "learning," "wisdom," and "completion" of the network when working in real-time.

• PANN has much wider functionality, flexibility, reliability, and intelligence than all existing classical neural networks.

Intellectual property for PANN [10, 11, 12] belongs to the startup "Progress, INC," Detroit USA, which is leading development in the field of PANN applications. The business formation and marketing of PANN products is handled by Omega Server, Inc, a Detroit USA startup. Explanation to Fig 1. To test the efficiency of pattern discrimination, 3 classes of patterns were added to the system plus 90 separate patterns not related to gastric radiographs. In total, there are 53 images in a group of classes and 104 images one by one (in bulk). After 15 seconds of training, the system correctly recognized the presented gastric radiograph and built a list of similarities of this image with other images sufficient to create a new class, for example, the "sick stomach" class. All three authors of this article combine extensive experience in solving inventive and scientific problems in the field of practical medicine with experience and knowledge in the field of neural networks and Artificial Intelligence. This experience was implemented in the development of neural networks like PANN and a set of projects - proposals for the creation of unique "smart medical products," partially and very briefly described below.

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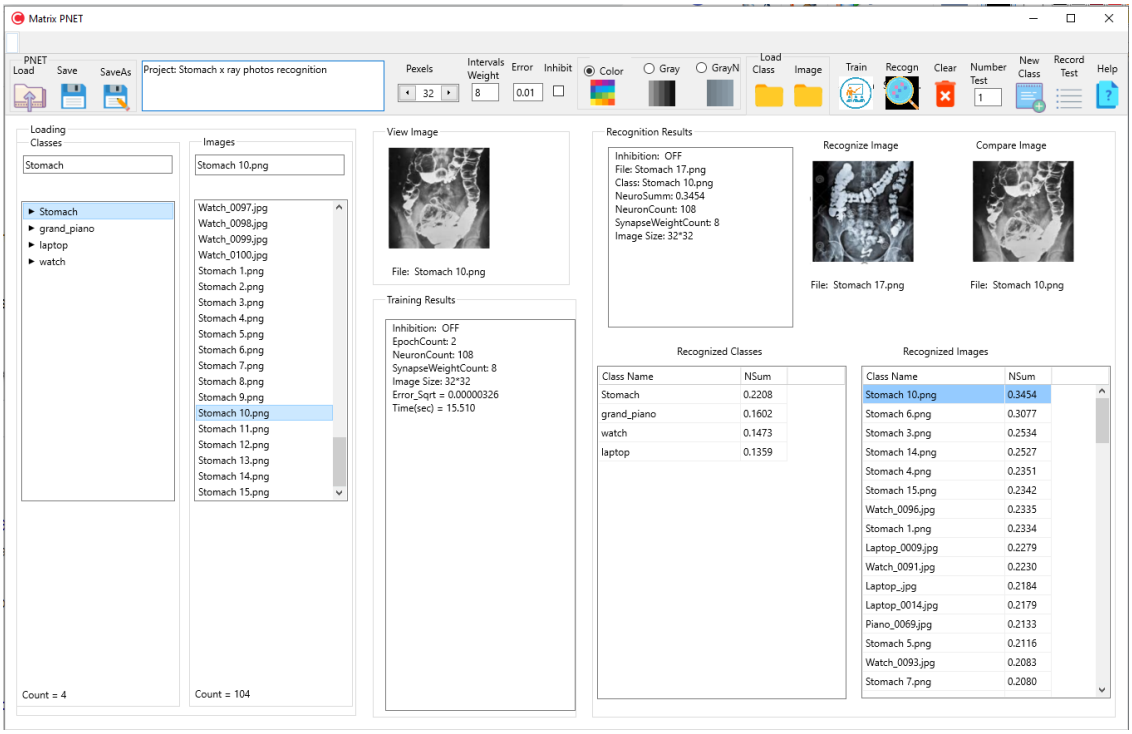

Fig. 1 Application of Progressive Artificial Neural Network for the recognition of gastric radiographs

PANN fundamentally changes this situation because it provides:

• A drastic reduction in computer requirements for PANN implementation allows building very powerful systems, not on supercomputers, but on mainframe machines, the cost of which is 10 to 100 times less than a supercomputer and available to most medical institutions and medical offices.

- The use of supercomputers and the ability of PANN to continuously complete training in real time will allow for the process flows of medical information throughout the country and therefore ensure:

○ Early detection of epidemics and other massive health impacts (both positive and negative).

○ Quickly select effective means of protection and fight against unwanted massive medical changes and constant monitoring of the results of actions in real time.

○ Rapid approbation of new drugs, treatment methods, health procedures, etc.

○ Searching for complex medical cases of close analogues in the world databases and predicting the development of the disease and treatment by these analogies.

- The interaction of PANN-based Alter Ego personal medicine systems, computer centers of medical institutions and doctor's offices, and powerful supercomputers integrating data on a national or even global scale will provide a significant improvement in the effectiveness of diagnosis and treatment for all diseases for most and possibly all patients.

It is clear that today neither medicine nor PANN is ready to deploy such work on a full scale. However, the creation of separate PANNs can be utilized for the diagnosis and/or treatment of some specific diseases, tracking treatment results, constant health monitoring of people at risk, and following test results and risks of exacerbations of chronic disease with the tools developed by Progress. This comprehensive approach and this kind of work can be done by small teams of medical practices and programmers.

Some possible applications of PANN together with TRIZ for carrying out important research in the field of medicine, invention, and development of new medical instruments, and diagnostic, and treatment methods are described below.

Intelligent Database Management System in Medicine (IDBMSM)

At the current time, we are dealing with badly structured "warehouses" of medical data that is invaluable for public and individual health problems. The use of these information reserves is very limited and requires expensive and more time-consuming work, which diminishes the value of the data analysis due to delays in producing useful information, which could be used to potentially save patients with declining health conditions.

For example, recording body sounds using a microphone system throughout the body can diagnose

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multiple medical problems or even predict disease exacerbation based on sounds generated by vascular blood flow, joint movements, muscle contractions, sounds of gastrointestinal and pulmonary systems, and even intracellular processes. Also, an analysis of the distribution of temperatures throughout the body, nerve signals, and various secretions of the body can provide enormous information. Even more, information can be obtained by sending various general or local signals to the body - mechanical, electrical, electromagnetic, chemical, complex - and recording the body's responses to them.
These potential methods of early detection could identify early disease and prevent catastrophic health issues.

Several decades ago, great hopes were pinned on the development of medicine at the expense of Large Databases of various types. Unfortunately, these hopes were very poorly realized. The Large Databases (mostly relational) accumulated today are unaffordable. It is difficult to get the required information due to the weakness of the existing Database Management Systems (DBMS), the analysis of these databases is very difficult, costly, and unreliable.

The PANN neural network allows for the creation of an effective Smart Database Management System (SDBMS) capable of accumulating data and automatically conducting:

- Rapid response to emerging changes in the patient's condition, including in real-time, for example, during surgery, emergency department, urgent care, etc.
- Fast forecast for all received data using neural network regression methods
- Comparisons with similar medical situations available in different databases and the use of existing information from databases to predict the course of a specific disease and outcome for a specific patient.

- Identification of general patterns associated with different "focusing factors" - patients, diseases, applicable methods of treatment, medical institutions, individual general physicians and different specialty doctors, etc.

This work will provide a pre-alarm when there are

- Undesirable trends in the development of the health condition.
- Immediate deterioration and risk of worsening health condition for the patient.
- The emergence of unforeseen situations or changes in the health situation.

At the same time, the software can include TRIZ tools compatible with PANN networks, including:

1. A special questionnaire (ISQ), which provides the accumulation of additional knowledge about the patient, patient groups, epidemic processes, known approaches to protection from infection, other common diseases and which will help in choosing choose health management, treatment approaches, etc.
2. A set of inventive problem-solving operators modified for medical purposes and health conditions from medical practice, the development of medical equipment, processes, and instruments corresponding to these operators (principles).
3. A set of patterns and developmental lines modified for medical purposes.
4. Forecasting (Predicting) the development of a disease or epidemic situation in conjunction with the use of the AI described above based on PANN networks.
5. Development of existing and the creation of new medical methods, instruments, and equipment.
6. Modified for medical purposes, software like "IP Evaluation" to perform the function of "Health Condition Evaluation."

Because PANN networks, unlike classical neural networks, allow for learning in real-time, completing and scaling at any time, there is no need to immediately start with "global projects." We can start building such networks for certain, most common groups of patients at a lower cost, and integrate the main parameters of diseases, diagnostic protocols and procedures, treatments, further prevention, etc. over time in the form of software products, including other existing databases, etc.

System "Medical Advisor"

About 30 years ago, all over the world, great success was expected from the creation of "expert system" type software. It was believed that the accumulation of the experience of many specialists and their transformation into some "rational rules" with the help of special programming languages such as "Prologue" and "Lisp" could provide a very effective diagnosis of any disease, the optimal choice of drugs, and treatment procedures.

These expectations did not materialize. Most importantly, it turned out that the basis of diagnostics and medical therapies is not so much the rational thoughts of doctors as the intuition of experienced physicians, which seemed impossible to teach machines.

The PANN neural network of the Omega Server company allows for a hundreds and even thousands of time reduction in the training time and costs for creating neural networks and creates effective expert systems of a new generation that integrate the use of:

- Explicit verbalized rational knowledge of professionals, recommendation of textbooks, monographs, etc.
- Intuitive, implicit, not verbalized experience of many physicians.
- Latent regularities (patterns) “dissolved” in knowledge and databases, identified through the “neural network intuition” of PANN.

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At the same time, there are opportunities:

- Development and replenishment of the system with each new medical case, which is immediately included in the training of the AI system, and with the advent of new diagnostic methods, new treatment protocols, new drugs, etc.
- Search for each specific medical case analogs in databases and predict the development of the disease by analogies.
- Fast and reliable medical training based on PANN-based simulation models.
- Checks emerging assumptions, theoretical models, etc.

It seems possible to develop 3 (possibly more) specialized types of "medical advisors":

- "Medical advisor" of a medical institution - general supervision over the course of procedures, coordination of care, alerting for new problems or upcoming health deterioration etc. - quite common functions of the control software can be supplemented by "machine intuition" - the ability to identify certain correlations and patterns, both within the information given by health institutions and on the basis of network information.
- The physician "Medical advisor" for general practitioner, different medical specialties, and medical staffing (PA – physician assistant, NP- nurse practitioner, RN- registered nurse, MA- medical assistant etc.)
- The patient "Medical advisor" – management of current illness, chronic medical diseases, reminder protocols on medications management on a regular doctor's visits. There is preventive medicine with dietary approach to problems like weight management, indigestion related issues, musculoskeletal problems. It is also based on individual patient medical ailments, etc. (diabetes, hypertension, hyperlipidemia, etc.).

And in this case, the advantage of PANN is the ability to start with cost effective budgets for any medical project, for example, diagnostic approaches to one particular disease or assessing a treatment protocol or the health condition of a particular group of patients, etc. And then, as experience and data accumulate, expand the application of the system.

System "Personal Physician"

The main problem of medicine today is that the focus is less on the individual needs and differences of patients and their medical conditions. Instead, medicine today provides treatment to a general population, for disease in general without considering a patient's individual characteristics, and this approach is not working efficiently.

The transition to widespread use of medicine (medical services) in the 19th century provided some improvement of access to medical care to the wider population (in the position of the masses), but, as usual with the transition to mass production, the quality of service fell sharply.

Mass medicine, based on the development of science, began to improve in the middle of the 19th century, thanks to novel developments, primarily antiseptics, vaccines, universal drugs such as aspirin, later antibiotics, diagnostics and therapeutics technologies, research and development opportunities etc.

This approach helped the major populations to get rid of massive bacterial epidemics, treat injuries, and reduce child mortality. However, it has remained weak in areas of more individual disease and personalized medicine, including multiple allergies and unconventional reactions to mainstream drugs and therapies.

The system "Personal physician" is a "private" personal software that accompanies a person throughout his life, receiving and processing information from special sensors, network sources and the "owner" himself (including in the voice communication mode), and other sources. It is based on the constantly learning neural network PANN, which stores and analyze in the "Smart Database Management System" all the necessary medical data and data on the functioning of the organism of its "owner."

The "Personal physician" is a system (as a health coach) of helping people in maintaining **physical and mental health, and may slow down the aging process:**

- Tune in through self-training for a specific person, to take into account the individual organism's genetic tendency to disease, its lifestyle, nutrition, environment, activities, etc.
- Effectively work with telemedicine systems, computers of medical institutions and authorized medical personnel.

This program, which accompanies a person all his life (health coach), can provide early diagnosis and prevention of diseases and the occurrence of addiction habits (smoking, alcohol, drug addiction etc.), suggest the right diet and nutrition based on a complete analysis of a specific person, regulate drug – drug and drug – food interactions, and connect with necessary services in case of emergency or need for additional professional services etc.

It is very important that the program will be able to identify personal characteristics and correlations. Suggestions will be made according to: what is the reaction to various stress situations and medications, what causes allergies, what food and nutrition is preferred etc., as well as physiological, mental, age-related, etc. changes.

Constant unobtrusive, inconspicuous medical support will allow people to gradually optimize their nutrition, habits, work stress load, sport activities, recreation regimes, hobbies, and to some extent even relationships with other people, etc.

This tool is most useful for a physician or AI, who is a "personal physician," who thoroughly knows their patient and is best able to prevent medical errors. It will help doctors find analogs (other people with similar

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problems), make disease predictions, and identify any dangerous deviations at the earliest stage.

A huge and ever-increasing contribution to medical care today is made by artificial organs, prostheses, and implants, from ordinary glasses to a Teflon joint, "smart" pacemakers, microchips that regulate the supply of insulin, etc. At the same time, there is an active development of external medical devices, from massagers, oxygen sources, defibrillators, and means of announcing a "medical alert." Both of these areas will continue to develop and strengthen rapidly, with the "Personal Physician" becoming an ideal candidate for coordinating the actions of all artificial medical devices.

Classical medicine is mainly aimed at combating fatal or at least very harmful and painful diseases. But there are also many minor ailments, which are usually not paid attention to until they develop into more harmful conditions. In the long run they cost humanity in the form of lost energy, mistakes, and mood changes, in general, more than major diseases and epidemics! And it is very likely that these "little things" require more frequent medical attention and at times significantly reduce life expectancy and life satisfaction.

A "personal physician" is able to find correlations of "minor ailments," both in a particular person and in different groups of people and to help identify their causes and identify meaningful solutions and prevent the exacerbation disease process. This should greatly decrease the cost of future medical care and will improve the quality of life of the patients and their satisfaction with it.

It is likely that such a PANN-based continuous feedback system will also allow some of the capabilities of alternative medicine, such as acupuncture, massage, nutritional supplements, tempering procedures, and biofeedback techniques, to be used effectively.

And in this case, the advantage of PANN is the ability to start with some not too expensive, limited projects, for example, the “smart PANN network” tied to one of the existing medical remote systems (for example, to the system of care for diabetics or sick children), using the existing devices, sensors, and databases. The project may be low-cost and early to reach self-sufficiency and development at its own expense.

Medical Assistant Researcher System

"The Medical Assistant Researcher System," a set of neural networks capable of

supporting the most important research processes:

- Accumulation and classification of information. This function can be performed by most of the existing software, but they always lack "intelligence" to do it adequately. And the PANN-based DBMS described above can provide this.
- Associative search for additional information in different networks and databases is a function implemented on the basis of the PANN and TRIZ association
- Generation of new (inventive) ideas and concepts, that is, "invention of explanatory models," including models of natural processes (virus spread, infection, incubation period, disease, etc.) and "resistance models" - both natural and artificial, stimulated by medical procedures. And also, the invention of methods of protection against disease, diagnosis and individual based disease therapy. All of this is an important function implemented based on the PANN and TRIZ merger.
- Self-optimization and self-adaptation of the system to the habits and methods of work of a particular researcher.
- Ensuring the integration and coordination of the work of different researchers using compatible systems "Medical and Researcher assistance"
- The Research assistance can be initiated. Work can begin with developing such a system for one R&D project and in the process of collecting data will research it, improving it and involving other similar or close projects, articles etc., to follow the pattern and for better and faster discoveries in the work. It also will minimize or even eliminate the common R&D trial and error approach. Over time, a set of such software with a common "coordination module" can become a tool for creative management of research for large teams of scientists.

Medical Control System “Identify the Error or Mistake"

The third-largest cause of death in America, about 450 thousand per year, are medical errors, which are theoretically completely preventable. This is more than the death rate from a current problem: COVID-19! The average person has the probability that within a year he will die from a medical error on the order of one-thousandth. This is a significant implication for human life.

Moreover, besides fatal medical errors, there are plenty of non-fatal ones that may harm a patient, limit working capacity, detain him in the hospital for longer care, increase the cost of care etc. If we estimate that people die from no more than 1% of errors, it turns out that each of us has experienced about 10 non-fatal medical errors in our lives. Scary!

Of course, in order to reduce the number of errors, there are multiple measures that are being taken, mainly reduced a paperwork time and increase time with patients, control on medication errors by adding pharmacy personnel and nursing for complex care. Unfortunately, during our practice in the field of medical invention in the hospitals, we still observe a significant number of medical errors on different levels of patient care from physicians, nursing, ancillary staff etc.

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The use of numerous computers and surveillance cameras didn’t solve the problem as well because it is lacking sufficient "intelligence" to the surveillance systems.

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Using existing surveillance systems in conjunction with networks like PANNs with high intelligence and the ability to learn in real-time can provide a breakthrough in this area, providing a real system of protection against medical errors.

System "Development of medical technology"

As mentioned above, Omega Server employees have a wealth of experience working with the US medical industry. The main conclusion from our experience in the development and production of medical devices in the United States and some other Western countries (in which we have experience) is the low level of creative capabilities of the vast majority of engineers, leading to:

- Very slow pace of development, and very high cost of development and testing, primarily due to the fact that all work is done by trial and error and has a low level of creativity.
- An abundance of errors and harmful effects, which are often revealed after the start of sales and widespread use of equipment, causing costly revisions.
- Low "intelligence" of the equipment, which manifests itself in the limitation of its capabilities and difficulty of maintenance.

Both problems - lack of creativity in the development and lack of intelligence - can be, if not completely eliminated, then greatly reduced with the help of two main "talents" of the Omega Server: - using the company's experience in TRIZ, especially the Directed Evolution service and PANN networks.

Mass public medical observing and monitoring system

In 2007, in the course of one of the medical projects, we came up with an invention that provides early detection of massive medical problems, such as epidemics, poisoning, dangerous violations of environmental conditions in certain regions, etc.

But this required coordinated efforts on the scale of fairly large regions. A provisional patent was filed; a presentation was made at a scientific conference, and attempts were made to gain the attention of the medical bureaucracy department in the United States, which ended without response. During the COVID 19 epidemic, we repeated these attempts - but with the same zero results.

The essence of the idea is simple:

To detect massive health disorders of epidemics without knowing exactly what symptoms to look for, the concept of ensuring medical information transparency can be used. With the use of information resources, correlations of various parameters related to human health are revealed on the basis of the statistical processing of large volumes of information.

This means that it is not necessary to detect any special symptoms as the appearance of some statistically significant systematic deviations from the normal state can increase the chances of a certain population group becoming ill.

There is no doubt that after infection, even during the incubation period, when the disease does not have strong manifestations, there will certainly be some kind of disruption of normal functioning, changing some parameters of the state of the body, for example,

- Temperature
- Blood pressure
- Chemical characteristics such as pH at the surface of the skin or in the blood, the amount of blood sugar, etc.
- Various disorders change sounds of organism based on disease cardiovascular (heart rate- bradycardia, tachycardia, irregularities, etc.) gastrointestinal (bloating, nausea, etc.), pulmonary (cough, shortness of breath, etc.) ENT system (runny, stuffy nose, voice changes, etc.) musculoskeletal (joints cracking, muscles spasms popping, etc.)
- Electrical rhythms of the brain (alpha rhythm, beta rhythm, etc.)
- The electrical potential of some active points of the body, etc.
- Changes in weight, feeling sluggishness, generalized fatigue, sleeping disorder, disbalance in the menstrual cycle, sexual activity, etc.

It can be expected that in connection with infection and/or the onset of the action of the immune defense, the following typical changes may occur (together or separately):

- The body parameters that fluctuate by weak change or abruptly, rhythmically, or chaotically with a sufficiently large amplitude.
- Disrupted rhythm of rhythmic processes (e.g., heartbeat)

In processes with stable dynamics under normal conditions (for example, changes in temperature and blood pressure during the day), periodicity violations, chaotic jumps, or new periodicities

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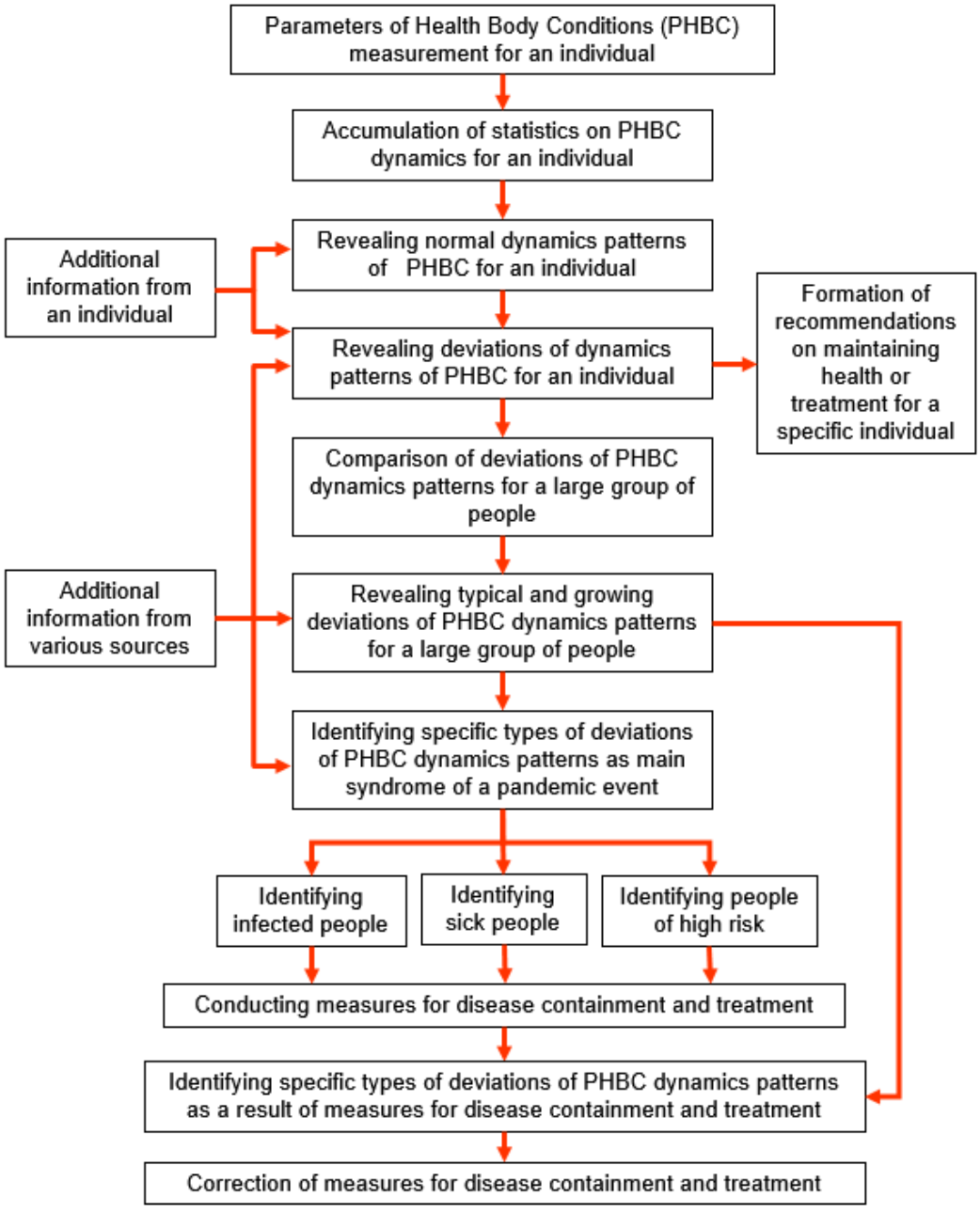

14 years ago, when this idea originated there were two obvious difficulties:

1. Providing a large number of people for the study with similar types of sensors problems and creating a network for collection data information.

Nowadays this is part of the practice and no longer a problem. Household medical sensor devices can be used. It is not difficult and not expensive to mass-produce them and collect information through telephones.

2. Processing huge amounts of information and identifying statistical correlations was difficult in 2007, the processing time would take too long, which made the system useless.

Today, there are neural networks that can partially solve this problem but at the same time create others. The need to use very expensive equipment and expensive training procedures and the too-long training period makes it very difficult to consider the large-scale changes in the state of people associated with changes in climate, nutrition, technology, social changes, etc.

It makes it completely impossible to assess and support measures directly, especially in the process of an epidemic when the speed of obtaining and processing information of new actions (drugs, procedures, measures of the authorities, etc.) becomes a decisive factor.

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In this situation, the advantages of PANN networks become decisive - the ability to use affordable (not expensive) technology, very fast and simple staff training, the ability to constantly supplement the information in real-time, identify hidden correlations and patterns, etc. The information transparency inherent in PANN allows not only to detect correlations, but in many cases to understand the patterns hidden behind them, and therefore quickly assess the effectiveness of certain means of influencing the disease and finding effective means of influence.

Unlike previous PANN medical applications, this one cannot be implemented at the "lowest level," but it can be implemented at the level of relatively small regions - for example, a medium-sized city or rural area and at the level of some large companies, or, for example, universities, which could create a system for monitoring the health of their employees (including students). Both options can provide the funding opportunities.

There are several avenues that could benefit for an efficient AI solution.

Data Management

One such project would be with a data management company that connects many different stakeholders in the healthcare industry.

Dermatological Pattern Recognition

Another area I would like to explore is in pattern recognition for diagnosing and monitoring patients in any category, for instance, dermatologic lesions. There is a strong need to be able to identify and diagnose suspicious lesions and monitor the effect of treatments. I have access to several large dermatological medical practices who can benefit from this technology. This can also translate to pathology, in being able to more accurately diagnose pathology samples in a more efficient time frame.

Oncology Treatment and Management

With the recent emphasis of personalized medicine in the oncology arena through next generation sequencing, the need for AI is critical to managing oncology disease. There are infinite variables on a genetic level that influence the progression and prognosis of a disease, which requires a tremendous amount of analytical power to find the most effective treatment

Telemedicine

Having digital solutions to assist physicians has become more relevant with the recent adaptation of telemedicine. Since patients are not in physically in front of the patient, diagnostic tools are essential to aid the physician in caring for the patient an AI solution that can use a phone or computer camera to automatically monitor temperature and vitals as well as identify other physiological anomalies can be a tremendous benefit in this area.

System of Medical Education

Existing medical education systems can be divided into two major areas:

1. Education of the general public about the correct attitude to their health and correct response in the face of possible health hazards.

In many problems with their health, people blame themselves. They give in to their desires, overeat, have increased stress reactions, nervousness, emotional breakdown, etc. In this case, it is very important to become there "health coach" to prevent and avoid stress induced health related disbalances "Smart" software systems created on the basis of PANN can be observing and monitoring changes, inappropriate disbalance or dangerous and hazardous behavior of a person, for example, in business offices, large medical facilities clinics, hospitals (emergency department, urgent care, etc.), or public premises, public transportation systems, public premises, schools, large public events, even in restaurants, etc. that monitor customers. The observing and monitoring of customers will collect data and inform responsible authorized personnel as it will be programmed in the "intellectual system."

2. Training of medical personnel. The programs are used in the training of doctors, especially with the help of various reality simulators. However, the PANN system will allow for each medical student to create his own personal "medical advisor" who will simultaneously study and recognize his "master," adapt to his personality, and teach him in a professional sense, in cooperation with the university's educational systems.

Conclusion

We have translated a brief rationale for the application in medicine of a new class of neural networks "Progressive Artificial Neural Network" together with elements of the modern Theory of Inventive Problem Solving. This is the beginning of a new stage in the development of medical practice and, to some extent, also of medical science. In reality, not all of the described systems may go into development, new combinations of the described possibilities may arise, and applications that we today cannot even predict will undoubtedly appear.

Significantly, there are very attractive new opportunities that researchers, professionals, and investors can take advantage of to create new treatments, products, and services.

Progressive artificial neural network for medical applications

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This article is presented by professionals, working in diverse fields and combining their knowledge in artificial neural networks with decades of experience in application of TRIZ, the Theory of Inventive Problem Solving. The

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article describes problems associated with the impossibility of effectively using existing neural networks for the analysis of medical information. Their solution proposes utilization of the recently invented, fundamentally new system - Progressive Artificial Neural Network (PANN). A description of PANN and its advantages is presented. The example of PANN implementation is shown with some possible applications of PANN, together with TRIZ, for conducting important research in the field of medicine, invention, and the development of new medical equipment and diagnostic and treatment methods. In particular, the authors propose:
• Intelligent Database Management System in Medicine (IDBMSM),
• System "Medical Advisor"
• System "Personal Physician"
• System "Physician Assistant - Researcher"
• Medical Control System “Identify an error (mistake)”
• System "Development of medical technology"
• System of mass medical monitoring
• Medical training system
The authors believe that the use of the PANN system will be a very important step in the development of both the theory and practical aspects of medicine.
Keywords: artificial neural network, medical applications

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