

Fundamentals of thinking, patterns

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Abstract. The authors analyze the fundamentals of thinking and propose to consider a model of the brain based on the presence of magnetic properties of gliocytes (Schwann cells) because of their oxygen saturation (oxygen has paramagnetic properties). The authors also propose to take into account the motion of electrical discharges through synapses causing electric and magnetic fields as well as additional effects such as paramagnetic resonance, which allows combining multisensory object-related information located in different parts of the brain. Therefore, the events of the surrounding world are reflected and remembered in the cortex columns, thus, creating isolated subnets with altered magnetic properties (patterns) and subsequently participate in recognition of objects, form a memory, and so on. The possibilities for the pattern-based thinking are based on the practical experience of applying methods and technologies of artificial neural networks in the form of a neuroemulator and neuromorphic computing devices.

1 Introduction

The human brain also has evolved like the human body with its sense organs. The brain belongs to our planet Earth at least in its basic ancient parts, appears, and changes in its embryonic development repeating the evolution. Its change is closely related to the change of the human body. Simultaneously with the development of the embryo, autonomous self-regulated control systems with the basic life-supporting functions of the body appear in brain regions.

Unconditioned reflexes attributed to the human cognitive functions are embedded in a human being as a necessary and sufficient condition for survival and development of the organism on the surface of the planet Earth. If necessary, in case of stopping development of the embryo on the third week, apparently from the same material, we can get amphibians able to live and breathe under water. In embryonic development, the more ancient parts of the human brain (oblong, intermediate, dorsal and others) are formed accordingly; they provide vital functions for the human activity control regardless of the cognitive activity (a person in a coma with no signs of cognitive functions continues to exist, and in case of appropriate care he breathes, is nourished, etc.).

In full understanding, cognitive thought processes are manifested in the frontal lobes. Cognitive functions and the thought process are provided by formation and training of neural networks (patterns) of the cerebral cortex, which are cortex columns (subnets) consisting of neurons, synapses and gliocytes.

If there is a sufficiently strong excitation in one of the brain regions, an acoustic signal appears and the local neuron networks created perceive it with the same natural frequency. It means that the pattern is excited and it delivers the image recognized to the receptors of the second signaling system, i.e. we perceive the known object all over again.

Pattern-based thinking, as will be shown based on the realized and approved systems, allows using almost the same program by implementing it in the form of a neuroemulator or neurochip, because the



brain is also divided into isolated regions responsible for various functions of recognition and formation of an integrated solution.

Problems of acoustic and seismoacoustic analysis of encephalograms and cardiograms (solution for wave control processes) were realized in the artificial neural network *NeuroCiber*. Problems of analysis of images, geophysical and geochemical surface measurements (geomagnetic, gravity measurements, aerial photography, etc.) as well as problems of analysis of large data sets represented in the form of two and three-dimensional data were realized in the artificial neural network *NeuroInformGeo* (the patent available). Problems of analysis and forecast of economic, social, and political data as well as analysis and forecast of time series were realized in the artificial neural network *NeuroFinExpert*.

Realization of the proposed algorithms for the general solution of the wave equation by means of neural networks with creation of phoneme and encephalogram patterns and patterns of various diseases of the brain and heart allows us to solve a wide range of problems including recognition of mentally spoken phrases and their direct and mental transmission. We control artificial *NeuroCiber* objects by voice commands [1–3].

2 Human brain

The brain is millions of years old, but at the same time, it has rather young formations. Formation of the parts of the human brain occurred at different evolution periods and each of them was an independent self-regulating system. Let us distinguish the basic brain formations: the cerebral cortex, medulla oblongata, and interbrain. The interbrain (hypothalamus) contains the regions (volumes) of the nerve centers responsible for hunger and saturation. The medulla oblongata contains the breathing regulation apparatus.

3 Fundamentals of thinking

Neurophysiologists formulated the law of a nervous impulse transmission across synapses, identified visual and auditory zones, constructed a map of projections of thalamic nuclei on the cerebral cortex, and others. However, one of the most profound unsolved scientific problems is the nature of consciousness. How is consciousness generated by the brain?

The general structure of consciousness consists of **visual, auditory, tactile, and somatic** zones. All this zones are superimposed in a **living neural network**. It means that the method of calculation lies in the trained and constantly existing neural networks (when creating neural robots or at birth of an animal or a human being) and these neural networks form a system of unconditioned reflexes. They must ensure the survival of a living organism or a neuro robot in the real physical and temporal continuum (for a human being it is the planet Earth of the solar system in our Galaxy). Additional skills are formed in the same system, which means that the new neural networks are formed in other parts of the brain (conditioned reflex).

The basic paradigm is that only the following libraries of neural networks participate in all calculations: ready, inherited, formed at the previous stage or by previous generations of neural robots (as in our case), and neural networks trained during the life of living creatures or during the functioning of a neural robot in the real-time mode (patterns).

4 The basic concepts of brain activity of living creatures

1. Inherited (unconditioned) reflexes are obtained mainly during the evolutionary development of our organism; they ensure connection of the organism with a given planet and its daylight surface, and with an opportunity to return to the Ocean.
2. Conditioned reflexes are the basis for training, after-training and retraining of neural networks.
3. The function of pattern recognition is a fundamental property of a living organism. A fundamentally important feature of pattern recognition by a neural network is the ability to reconstruct an image from the data reduced, distorted or incomplete, and stored in the memory.

For example, a simplified image or its part is to be recognized and the task of the neural network is to restore the complete initial image stored in the memory.

4. Modelling of external processes and events (sleep is a period for cleaning, simultaneous and constant repetition of events already happened, highlighting the most significant ones and their memorizing, retraining of the networks already retrained).

5. Combination of training, after-training, and retraining with recognition and modeling of physical events and processes, which have really happened, leads to the appearance of conditioned reflexes and their consolidation, i.e. appearance of skills (for living creatures, it is usually associated with emotional experience reflected in a certain region on the brain).

6. Chaotic dynamics of the magnetic and electrical activity of the brain. Studies have shown that the electroencephalograms (EEG) of animals and humans, as well as magnetic fields generated in the interneuronic brain tissues, represent deterministic chaotic processes with a small number of degrees of freedom.

7. Parallel methods of processing of incoming and simulated information in the brain.

In this paper, the authors propose to consider a model of the brain, which includes the following aspects:

8. Magnetic properties of gliocytes (Schwann cells).

9. Subdivisions of the neural network structure of the brain, cortex columns (subnets).

10. Oscillation of various parts of the brain, resonance and feeding of the processed signals again to the first signaling system into the visual, auditory, and somatic zones in full or partial volume. These elements are necessary and sufficient conditions for constructing human thinking or thinking of another living creature based on patterns (experience accumulated in the previous life), which are both memory and means of recognition of objects and events [4].

5 Sense organs

Sense organs give us the world full of colors, sounds and smells.

Sense organs are analyzers that signal to receptors, i.e. cells that process and transform signals into nerve impulses.

Sense organs represent a specialized peripheral anatomical and physiological system, which provides (by means of its receptors) receipt and primary analysis of information from the environment and from other organism's organs, that is, from the organism's external and internal environment.

Remote sense organs perceive stimuli at a distance (for example, organs of sight, hearing, and smell) while other organs (taste and touch) perceive stimuli by means of direct contact only.

Some sense organs can supplement other organs to a certain extent. For example, the acute sense of smell or touch can, to a certain extent, compensate poorly developed vision (eyes) and smell (nose).

Human sense organs.

Information received by the human brain from the sense organs forms the person's perception of the surrounding world and himself.

A human being receives information through six basic sense organs [8–10]:

1. Eyes (vision).
2. Ears (hearing).
3. Tongue (taste).
4. Nose (smell).
5. Skin (touch, sense of pain, temperature) [2].
6. Vestibular apparatus (sense of balance and position in space, acceleration, and sense of weight).

6 Receptors

Receptors are cells that process signals into nerve impulses. Receptor is a combination of dendrite terminals (nerve endings) of sensitive neurons, glia, specialized formations of intercellular substance, and specialized cells of other tissues, which in combination ensure transformation of the influence of external or internal environment factors (stimulant) into a nerve impulse.

The principle of receptors.

Types of stimuli for different receptors include light, mechanical deformation, chemicals, temperature changes, and changes in the electric and magnetic fields. In receptor cells (either nerve endings or specialized cells), the corresponding signal changes the conformation of sensitive molecules - cell receptors, which leads to change in the activity of membrane ion receptors and change in the membrane potential of the cell. If the nerve ending is the perceiving cell (the so-called primary receptors), then it usually leads to the membrane depolarization followed by generation of a nerve impulse. Specialized receptor cells of secondary receptors can both depolarize and hyperpolarize. In case of hyperpolarization, change in the membrane potential leads to decrease in secretion of the inhibitory transmitter influencing the nerve ending and, ultimately, to generation of the nerve impulse. In particular, such a mechanism is realized in the sensory elements of the retina.

Types of receptors.

There are several classifications of receptors.

According to the adequate stimulus:

- Chemoreceptors. They perceive the effects of dissolved or volatile chemical substances.
- Osmoreceptors. They perceive changes in the osmotic concentration of the fluid (usually, of the internal medium).
- Mechanoreceptors. They perceive mechanical stimuli (touch, pressure, stretching, vibrations of water or air, and others).
- Photoreceptors. They perceive visible and ultraviolet light.
- Thermoreceptors. They perceive cold or thermal stimuli.
- Electroreceptors. They perceive changes in the electric field.
- Magnetic receptors. They perceive changes in the magnetic field.

The human being has the first six types of receptors. Taste and smell are based on chemoreception; touch, hearing, balance, and sense of the body position in the space are based on mechanoreception; vision is based on photoreception. Thermoreceptors are in the skin and some internal organs. Most interoceptors start involuntary and in most cases unconscious and vegetative reflexes. Osmoreceptors are included in the regulation of kidney activity; chemoreceptors, which perceive pH and concentrations of carbon dioxide and oxygen in the blood, are included in the regulation of respiration, and so on.

7 Neuron

A neuron (from Greek νῆρον - fiber, nerve) is a structural and functional unit of the nervous system. A neuron is an electrically excitable cell that processes, stores, and transmits information using electrical and chemical signals. A neuron has a complex structure and a narrow specialization. A cell contains a nucleus, a cell body, and processes (dendrites and axons). In the human brain, there are about 85-86 billion neurons. Neurons can connect with each other, thus, forming biological neural networks. There are receptor, effector and intercalary neurons.

8 Synapse

A synapse (Greek σύναψις, from συνάπτειν – connection, link) is a place of contact between two neurons or between a neuron and a signal-receiving effector cell. It serves for transmission of a nerve impulse between two cells; during the course of synaptic transmission, the amplitude and frequency of the signal can be regulated. Transmission of impulses is carried out chemically by means of mediators or electrically by ion passing from one cell to another.

The synapse creates discharges with a frequency of 1...100 Hz, the maximum value and exponentially decays, which is an alternating electric current generator. It generates an alternating magnetic field that changes the paramagnetic properties of gliocytes, which then provide associative memory by forming patterns in different isolated parts of the brain with pathways to the sense organs through the receptors.

9 Neuroglia

Glial cells are more numerous than neurons and make up at least half the volume of the central nervous system, but unlike neurons, they cannot generate action potentials. Neuroglial cells are different in structure and origin; they perform auxiliary functions in the nervous system providing support, trophic, secretory, delimiting, and protective functions. Glial cells have magnetic properties and contain paramagnetic oxygen-saturated solutions.

10 Cortex column

A cortex column (also called as a hypercolumn or cortical module) is a group of neurons located in the brain cortex perpendicular to its surface. Within one mini column, neurons have the same purpose, whereas a hypercolumn means the entire set of values for any set of parameters given by the receptors. A cortical module can denote a hypercolumn (V. Mountcastle) or a block of hypercolumns (D. Hubel and T. Wiesel).

The human neocortex.

The human neocortex contains six different layers, each of which can be identified by the type of neurons in it and their destination (inside the brain).

Modular organization of columns.

Modular organization of the columns was originally described by Vernon Mountcastle who suggested that the receptive fields of neurons located horizontally (relative to the cortex surface) at a distance of more than 0.5 mm (500 μm) from each other, do not overlap. Other experiments gave similar results (Buxhoeveden, 2002; Hubel, 1977; Leise, 1990, and others). Various estimates suggest that the hypercolumn is composed of 50 - 100 mini columns, each of which contains approximately 80 neurons.

11 Electromagnetic waves

The pulses generated by synapses and neurons are alternating electric current, which generates an alternating magnetic field.

The electromagnetic field in a vacuum is determined by the Maxwell equations:

$$\begin{aligned}\text{rot } \vec{E} &= \frac{1}{c} \frac{\partial \vec{H}}{\partial t}, \text{div } \vec{H} = 0 \\ \text{rot } \vec{H} &= \frac{1}{c} \frac{\partial \vec{E}}{\partial t}, \text{div } \vec{E} = 0\end{aligned}$$

This equation has solutions different from 0. Thus, electromagnetic field can exist even in conditions of absence of electric charges and in this case is called an electromagnetic wave.

For an electromagnetic wave, there is the d'Alembert equation (wave equation)

$$\Delta \vec{A} = \frac{1}{c^2} \frac{\partial^2 \vec{A}}{\partial t^2}$$

or

$$\frac{1}{c} \frac{\partial \varphi}{\partial t} + \text{div } \vec{A} = 0$$

The equation has a relativistic invariant character: postulates that satisfy it in one reference frame satisfy it in all others.

Thus, temporally taken alternating electromagnetic field generated by the human brain by means of thought processes, existed in certain periods of the space-time continuum and was emitted into the surrounding space.

12 Field interaction

Because of finiteness of the velocity of interaction propagation within the force field, change in the position of one of the charged particles is reflected in the other only after a certain time interval.

Therefore, the force field reflects physical reality and has a measure value (time and force characteristics). Charged particles do not directly interact with each other.

Thus, the charged particle interacts with the field and subsequently, after a certain time interval, the field interacts with another charged particle.

In the case of motion of a unit charge (anion, cation), forces affect it or it affects the surrounding field by force.

$$E = -\frac{1}{c} \frac{\partial A}{\partial t} = -grad\varphi$$

where **A** is an operation work that must be performed over the charge in order to move it in space; **E** is the electric field strength.

H = rot**A** where, **H** is the intensity of the magnetic field.

We should note that **E** is a polar vector, and **H** is an axial vector.

Equation of a charge motion in an electromagnetic field (Lorentz force).

$$\frac{\partial p}{dt} = eE = \frac{l}{c} [VH]$$

where eE is a force of action of the electric field on the charge; it does not depend on the charge velocity and is oriented along the direction of the **E** field.

$\frac{e}{c} * [VH]$ is a force of the magnetic field on the charge; it is proportional to the velocity of the charge and is directed perpendicular to this velocity and to the direction of the magnetic field **H**.

Only the electric field acts on the charge produces; the magnetic field does not act on the charge moving in it because the force of action of the magnetic field on the particle is always perpendicular to its velocity. This property allows the magnetic field to exist always and not to expend its potential energy for acting on charged particles. Thus, change of the magnetic field forms associative memory and, simultaneously, is an apparatus for identifying and recognizing objects (as in neural chips or the coefficients of the trained neural networks (patterns)).

13 Paramagnetic substances

Paramagnetic substances are substances that are magnetized in the external magnetic field in the direction of the internal magnetic field (**J**↑↑**H**) and have a positive magnetic susceptibility, but are much less than unity. Paramagnetic substances relate to strongly magnetic substances, their magnetic permeability significantly differs from unity. The paramagnetic substances have their own magnetic moments, which under the action of external fields are oriented along the field and thereby create a resultant field that exceeds the external field. Paramagnetic substances are drawn into a magnetic field. If there is no external magnetic field, paramagnetic substance is not magnetized, because atoms' magnetic moments are oriented quite randomly because of the thermal motion.

Paramagnetic substances include oxygen O₂ (1.000017), air (1.000038), nitrogen oxide NO, manganese oxide and others. The authors believe that oxygen provides paramagnetic properties to glial cells; air with impurities of other gases is harmful to the brain. Paramagnetic resonance was discovered by E. Zavatsky in 1944, i.e. when introduced into a constant magnetic field of intensity **H**, a rotating electric charge receives an additional rotation about an axis parallel to the field with the frequency of

$$\Delta\omega = \frac{Pm}{L\alpha} * H$$

$\Delta\omega$ is a procession of the magnetic moment.

If different radio waves are passed through a paramagnetic body placed in a constant magnetic field **H**, then in conditions of coincidence of frequency of waves with the natural frequency, the resonance phenomenon will appear and intense energy absorption of the incoming wave will occur.

When recognizing an object, which is already stored in the memory, each memory region is broken up into cortex columns, where the neurons, axons, and the nerve endings of the dendrites are the conductor and the surrounding glial cells are paramagnetic solutions (saturated with oxygen). It is the

memory that absorbs excessive energy during the neuron excitation and amplifies the current of the electrolytic reaction in its magnetic field. Therefore, because of the resonance, an acoustic signal is generated, which is perceived by the created local neural networks with the same natural frequency, i.e. the pattern is excited and it delivers the image recognized to the receptors of the 2nd signaling system; it means that we sense the object recognized once again.

14 Neural networks of the brain

1. Cortex columns - subnets as a repository of information.

The brain is divided into regions responsible for processing of visual, auditory, and other information and at the same time into cortex columns (subnets), which store information about every event.

Thus, subdivided neural networks are formed within each formation, the synaptic connections are much stronger and more numerous inside than between subdivisions.

A fully connected neural network containing N neurons is able to memorize $p = L_c N$ images, where $L_c = 1.185$. Analysis of the stability of images stored in the neural network shows that if all images are orthogonal to each other, i.e. there is no mutual correlation between the images, then $p = N$.

Information about the general composite image of the object is stored in different regions of the brain.

2. Partial ordering of networks - chronological development over time.

Let us introduce a concept of eventfulness as chronological discrete existence and development of the human life, and, accordingly, formation of memory as the most acute and strong excitation of certain parts of the brain at certain periods of time.

If during the day events are recorded continuously, then the period of sleep is spent on ordering and extracting the most significant events from the records and fixing them in a dynamic long-term memory.

Formation and training of these neural networks occurs using a second signaling system under the control of a specific region of the brain.

We denote a set of subnets created this way and consisting of the patterns formed as S_1 and a set of all networks representing all events in the human life as S . As time of pattern creation goes back and discrete memory can be built from continuous daytime wakefulness, then we can introduce a binary relation φ on the given set, which is called as partial ordering of this set (or a partial order).

Let us define the basic characteristics:

1. Individuality:

The relationship φ is a characteristic of particular individual because it is based on many memories or events S , which happened to this individual.

2. Generality:

The relationship φ has common properties inherent in all living beings. Let us denote φ by \leq .

$\forall x \in S$

P1. $x \leq x$ is reflexive for all $x \in S$.

P2. If $x \leq y$ and $y \leq x$, then $x = y$ is antisymmetric.

P3. If $x \leq y$ and $y \leq z$, then $x \leq z$ is *transitive*.

P1 means that if a given event occurred with a given person at a given moment and a pattern was created in the person's memory, then it could not participate at the same moment in a completely different event and in a completely different place.

P2 means that if an event occurred with a given person at a given specific time period and another event occurred with the same person at the same time period in another place, then it is the same event.

P3 is very important. If one event occurred with a given person before the next event came, and the third event occurred after the second one, it means that the first event occurred before the third one.

Thus, when building a discrete chronological chain of events in the memory of a particular person, as well as a chain of significant events for the whole community, we form the chronological memory

of a person in the form of patterns that connect multiple time and spatial scales related to the activity of the human brain.

Therefore, people can say, "It was before" or, "It was after".

A neural robot can exist precisely in a time scale, however, from the point of view of adaptation to the human society, it must also identify and record the most significant events for the surrounding people and use these phrases when communicating with people.

Let us consider some of the simplest properties of partially ordered sets and their projection on the mechanism of human memory formation.

a: The ratio inverse to the partial order $\varphi \leq$ is again a partial order, which is called dual to the first one and is denoted as $\varphi^{-1} =$

Thus, by definition, $x \geq y$ if and only if $y \leq x$.

Partially ordered sets can be conveniently described by diagrams as shown in Figure 1.

Example:

$P(3)$ is a set of all subsets of $3 = \{1, 2, 3\}$ partially relative to the ordered inclusion relation.

3 is today's state

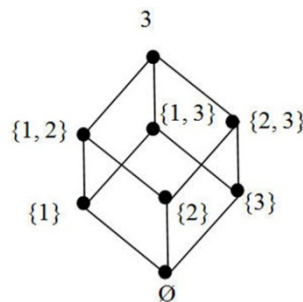


Figure 1. Diagram of a partially ordered set $P\{3\}$.

The duality principle (Theorem of theorems).

Theorem. In any general theorem about partially ordered sets of events, we can replace $\varphi \leq$ by reverse $\varphi^{-1} \geq$ without violating its truth.

If we consider the segments of the human life, we can assume that certain events will occur with him during the day or day-night period (month, year); their scheme is represented in the diagram. However, we can also introduce universal boundaries.

Elements O and I are called universal boundaries of a partially ordered set S (respectively upper and lower), if $0 \leq x$ and $x \leq I$ for any $x \in S$.

O is the smallest, and I is the largest element of the set S .

Lemma. In any partially ordered set $[S, \leq]$, no more than one minimal element and no more than one maximal element can exist.

Proving. Let O and O^* be the two minimal elements $[S, \leq]$. Then $0 \leq O^*$ and $O^* \leq 0$, according to P2; it means that $O^* = O$. It is analogous for I .

A person cannot live the life twice, or two different people cannot completely repeat the same event chronology, otherwise, this is the same person. According to this lemma, the event chronology can be very close for identical twins, because O and I are very close in time and space.

Definition: Let $P = [S, \leq]$ be a partially ordered set, a and b be its elements. We say that a dominates over b if $a > b$, but there is no $x \in S$ so that $a > x > b$.

It means that if the event a follows immediately after the event b , then several different events b can occur (b_2) at the next moment of time.

Theorem. Let $a < b$ in a finite partially ordered set P . Then P contains at least one chain $x_0 = a < x_1 < \dots < x_k = b$, in which each of the elements x_i ($i = 1, \dots, k$) dominates on x_{i-1} .

Thus, out of all the events that could happen to a given person, we can always construct an ordered chain of events in time and in space that had led this person from one point of the space-time continuum to a given point; moreover, no another event could be inserted into this chain of events.

By means of forming human memory out of the most significant events, we build an internal chronology of events in the form of a chain of patterns and using it, we can return to any point. It means the following.

Theorem. Let $[S, \leq]$, $S = \{s, \dots, s_i\}$ be a finite partially ordered set of events. Then the elements of S can be enumerated as $S = \{x_1, \dots, x_n\}$, which implies that $i < j$ follows from $x_i < x_j$.

15 Determination of a pattern

The approach oriented on combining the principles of training and interpretability corresponds to the goals and objectives of Data Mining. The authors lay down the foundation of the modern technology of Data Mining (discovery-driven data mining) by the concept of patterns reflecting fragments of multidimensional relationships in data.

These patterns represent the regularity typical of the data subsamples, which can be compactly expressed in a human-readable form. Patterns are investigated using methods that are not limited to a priori assumptions about the sample structure and the form of distribution of the analyzed indicator values.

The experience can be accumulated in the form of formation, preservation, and correct application of patterns (images), which represent a library of the neural networks trained during the period of training or during a real life. For people, $P(1)$ is important, i.e. the starting point formed in the childhood.

16 Application of patterns

Pattern-based thinking allows using almost the same program if it is implemented in the form of a neuroemulator or a neurochip and if the pattern coefficients files are being saved and loaded during the process of identification, recognition, etc.

In the artificial neural network *NeuroInformGeo*, the patterns were formed based on the already studied and drilled fields according to geophysical, geochemical, 2D, and 3D seismic data; new oil and gas fields were discovered in Eastern and Western Siberia and the Sakha (Yakutia) Republic (Russia) [5].

In the artificial neural network *NeuroCiber*, the patterns were formed based on the phonemes of a specific language and specific people, as well as on photos taken by the robot during the acquaintance; combination of audio-video based recognition led to a sharp improvement of identification and recognition of subjects as shown in Figure 2 [6, 7, 10].

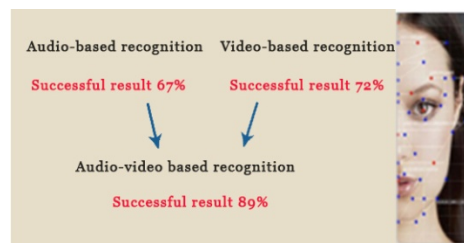


Figure 2. Audio-video based recognition.

In the artificial neural network *NeuroFinExpert*, the patterns were formed based on financial stability of groups of enterprises; it allowed analyzing and predicting economic, social, economic, and political results over time.

The latest SyNAPSE chip, introduced on August 7, 2014, has sensory capabilities at incredibly low energy level. IBM built a new chip with a brain-like computer architecture, which actuates 1 million

neurons and 256 million synapses. It is the largest chip IBM has ever built at 5.4 billion transistors, and has an on-chip network of 4,096 neurosynaptic cores. Yet, it only consumes 70mW during real-time operation — orders of magnitude less energy than traditional chips.

17 Conclusion

The brain sings. By exchanging musical phrases between different regions of the brain responsible for processing information from various sense organs, it synchronizes the composite image (pattern) and, when new information passes through it, the answer comes based on the previous accumulated experience.

There is a number of interesting points arising from this model of brain functioning. Sigmund Freud was right seeking the event in the depth of consciousness, that is, the pattern associated with this event and affecting the current psychological behavior of a patient.

IBM specialists draw an interesting analogy between conventional computer systems and the left hemisphere of the human brain. Neuromorphic systems can find individual patterns in large data sets and interpret this information as the right hemisphere of the brain. In the near future, scientists will be able to combine the capabilities of traditional computers and neuromorph chips and to create a single super effective structure – an artificial intelligence [4].

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