Language and Mechanism of Speech  
As controlling Interface with Environment  

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Abstract
In recent years the interest has been growing in human computer interaction (HCI). This interest reflects great activity in searching approaches for creation a new interface more fitting to human feature. This present paper discusses the problem of building a system of speech interaction in computer interface with control of interaction, suggested by the author. This is possible due to new opportunities to consider the development of language and the work of the mechanism of speech as a process of building a controlling interface with the physical and human environment.

1. Introduction
In the 1950s and 1960s the study of grammar changed radically with the development of transformational grammar, first by Zellig Harris and his student Noam Chomsky and then later in a different direction by Chomsky and his followers. A number of factors made the time ripe for the emergence of a rigorous and explicit theory of language structure. These factors included advances in mathematical logic, the advent of computers (sparking interest in machine translation and other natural language applications), and the weakening of the behaviorist hold on social sciences in the United States. The impact of Chomsky's 1957 monograph, Syntactic Structures, has been called revolutionary, and since the mid 1960s transformational ideas have dominated grammatical scholarship 1/.

The fundamental observation that was the starting point for transformational grammar had been made at least as far back as the early nineteenth century by von Humboldt. It was simply that human languages are infinite, in the sense that there is no limit to the number of sentences in them. Chomsky advocated the formulation of precise systems of rules that would distinguish sentences of a language from arbitrary strings of words. Much as the axioms and rules of inference in mathematical theory will generate infinitely many theorems, the rules of a transformational grammar should generate all and only the sentences of a language.

Having argued against various models of grammar for the description of natural language, Chomsky put forward his theory, known as transformational grammar. A transformational grammar consists of two parts: a base grammar, which generates a set of abstract structures (called underlying or deep structures in some versions of transformational grammar), and a set of transformations, which are rules that turn the underlying structures into the actual sentences of the language. Among the most widely discussed transformations proposed for the grammar of English are a rule to derive passive sentences (e.g., Wine was being drunk by children) from active underlying structures (in this case, the deep structure of Children were drinking wine) and a rule to propose question words (deriving What did you eat? from an underlying structure in which what follows eat). Various formulations (employing several notations) have been proposed for these rules and for the many other transformations that have been posited.

It is important to note, as it is imagined by Chomsky, that the inputs to transformations are not themselves sentences. Rather they are representations of the phrase structure of the sentences, often containing elements distinct from anything that appears on the surface. In the examples above, for instance, the underlying structures would not specify the inflectional forms of the verbs (e.g., was versus were), since these are affected by the operation of the transformations.

Chomsky goes on to advocate a rather strong version of nativism, claiming that the only way to account for the speed and ease with which children acquire language is to assume that much of what they appear to learn is genetically determined. Since any normal child will acquire whatever language he or she is exposed to, Chomsky's position entails a commitment to the claim that all human languages share a common core of structure. The goal of transformational grammar is to determine what this core - or "universal grammar" - the Chomsky grammar, as it is often called, consists of.

Although transformational grammar has held center stage in grammatical scholarship since the early 1960's, other approaches to the study of linguistic structure have been pursued as well. We think that one of them deserves
to be mention here as very important. It is one which
notices that Chomsky's approach treats language strictly
as a matter of individual psychology, failing to consider
it as a social institution. Hence it has little or nothing to
say about variations in language usage due to class, race,
social context, or other external factors. Chomsky's
approach appears to state that the language has no
connections with outside world. According to Chomsky's
theory semantics do not compose the links of elements of
a language with objects and states of environment, but
defined by innate nature of the mind. That is why the
philosophers John Austin and Paul Grice independently
pioneered the investigation of the uses to which language
can be put and the mechanisms people employ to achieve
various ends with language. These lines of research (as
well as other work) have led to an increased appreciation
of the ways in which linguistic communication can go
beyond the conveyance of the literal meanings of words
and sentences, and to the recognition that the structure of
language is heavily influenced by its communicative
functions. Indeed, even transformationists are now aware
that grammatical research cannot be confined wholly to
intrasentential relations, but must look at the wider
context - linguistic and nonlinguistic - to correlate forms
of language with facts about who is using them and to
what end. Because essentially the ability of
communication defines the efficacy of a language.

Although Chomsky could not practically apply his
idea to such a thing as computer translation of any
language, we can say with confidence now that he has
voiced two ideas of exceptional value: the first
concerning availability of speech phenomenon, which he
has called linguistic competence, and the second
concerning availability of speech phenomenon, which he
has called linguistic performance.

It is very important to notice that for a long time in
psychology and physiology the mechanism of the mind
was considered as the regulative, controlling mechanism
of our behavior. However it has not been possible so far
to explain many of the manifestations of the mind's
activity as a process of control. As a result, specialists in
the area of artificial intelligence have been building the
mechanism of mind and, in particular, the mechanism of
speech, as purely a logic-mathematical model /2/.

The result of research of the process of learning
presented in /3/, in which it has been proved that this
process is a process of control, makes it possible to view
the processes of generating linguistic competence and
displaying linguistic performance from a new point of
view.

Our research, thus, allowed us to draw a conclusion
that the phenomena of linguistic competence and
linguistic performance are to be understood as two
sides of the process of learning-control of the speech
activity. And what is more, this process of learning-
control must be understood as a process of a creative
building of controlling interface with the environment
and as an area of stability of human behavior.

2. Learning and Control

In cybernetics the word "control" is understood as an
action directed towards an object (or a process) which is
chosen out of a multitude of actions in accordance with
the given goal, the state of an object (a process) and
characteristics of an object, that leads towards the
improvement of functioning and developing of an object
/4/.

In commentary on this definition contained in /5/ it
is noted, that the "control does not suppress or enforce a
course of a process contradicting its nature. Quite the
contrary, taken in to consideration first of all must be the
nature of a process, and coordination of action as directed
upon the process with its logic. In the control of the
process of learning as well as in the control of any other
processes, freedom is displayed as a cognized necessity.

Such an interpretation of control is identical, in our
view, to the more constructive definition given by
V.Smolyaninov, whose idea, in its turn, was taken from
the works of N.A.Bernstein and A.A. Ukhomsky:
"Control is a goal action of the reduction of the excess of
freedom of the system (structural and/or functional)
organization" /6,107/, what suits the semantic formula of
organization presented there:

(Excess, invariants) ----------- Organization (1),

This is equivalent according to the author’s opinion /6/ to
the author’s definition of control and can be presented as

(Excess, invariants) ----------- Control (2).

In this case the meaning of the last formula must be
understood as: The control is a reduction (removal) of
an excess by means of secretion of invariants in
accordance with the given goal. In the last semantic
formula the most important point for us is that as noted in
/6/ as it is a matter of principle, namely as a matter of
essence of control.

Indeed, the variety of concrete systems of control
(biological, mechanical, electrical and so on) shows that
the material variety of its embodiments bears testimony
of immaterial essence of control. For the notion of
control there is an important meaning of symbolic
significance - the immaterial semantic essence -
information /6/.

Not belittling the dignities of definitions of control
and organization in /6/, in semantic formula (2) instead of the excess of degree of freedom it must be understood the redundancy of information in general, and instead of invariants - the valuable information, which the control system selects in accordance with the given goal (the law) of control in order to use it then for expedient control actions.

Control can be classified as two types: open-chain and circular. The first - the control without the feedback, that is without regulation of the course of the controlled process. The second supposes both the feedback and regulation of the course of controlled process, thereby ensuring both stability and development of the system, which means that it is more efficient than the first.

The control is always goal-directed. In one case the goal of control will be the maintenance of the controlled object's (process's) parameters within certain limits. In other cases the goal of control will be the fulfilling of the law (the program) of the control, that is to say, the transfer of object from one state to the other. In other words, both the significance of object's starting state and final state are important.

Information about the state of the controlled object (process) as determined from its exit is received on the feedback channel to comparative element, where is selected the valuable information in accordance with the goal (the law) of the control. Then based on this valuable information in regulator is generated corrective signals - controlling actions on the object (the process) of control.

It may be that the external conditions determining the infinitive actions on the object may be defined as having relative stability and as well as having possibility to change itself so rapidly that reaching the goal will become not possible, saying nothing, there may be case in which an action for a system may be sheer destructive. In this case it is generally agreed that the system does not cope with the control or the control is not efficient.

It follows, that in order for the control to be effective, that is successful, for so called "freedom of maneuver", in the general case, for self-organizing, self-developing system, "there is a need to create those freedoms - this excess of possibility, which then overcome in actions of control and self-organization"/6,109/.

This is displayed dialectical unity of the process of control. For its successful fulfillment in general along with the procedure of reduction (removing of redundancy) of information for a self-organizing, self-developing system there is a need to perform a collection, a searching of varied information, to create its redundancy.

In other words for the following selection of invariants the system must have varied information on the basis of which in actions of control is determined the property of immutability that is the invariability. This means that the process of learning is a process of control. This conclusion can be expressed in the law of control - learning as the following formulation:

Control is the dialectical unity of a process of creation of freedom (redundancy of information - diversity of information) and a process of its reduction (removal of redundancy of diversity of information) in accordance with the goal (the law) of control.

3. Language and Speech - Products of Activity of Mind as a System of Control

The process of perception and generation of speech is a wonder. Examples are by no means lacking. Here is how N.Zhinin describes the perception of a speech: "...the very various sounds confluence inside the flood of syllables is not the hindrance. On the contrary they tie together the flood of syllables in well recognized integrity possessing its own importance. They are recognized as integrity in the same manner as any other things. In order to recognize our acquaintance we do not need to look at him and "identify" one of his eyes, nose, ears and other components of his face"/7,17/.

Such an integrity possessing its own importance is a sense of statement. It was L.S. Vygotsky, who with great lucidity said about it: "Thought is not cheerily expressed in a word, but is accomplished in it...Thought does not consist of separate words - as a speech. If I want to transfer a thought that I saw today how a boy in blue blouse and barefoot was running on a street, I do not see all this separately, separate the boy, separate the blouse, separate that it is blue, separate that the boy was running. I see all this together in a single act of thought, but divide it in speech in separate words...The speaker often develops one and the same thought through several minutes. This thought is contained in his mind as integrity and does not arise gradually by separate units as the speech develops. That what is contained in thought simultaneously is developed in speech successively"/8, 28/.

This process is a genuine wonder owing to its ability generating new statements, since understanding and expressing statements are based on that internal mechanism of outcoming, generating. It is a well known fact that we acquire vocabulary by means of remembering, but we cannot acquire in such a way the supply of statements /8/.

Namely that is why both the perception and generating of speech are based on the mechanism of generation of statements. This ability of human mentality
for generating statements was called by author of transformational grammar N. Chomsky - linguistic competence, which he has defined as potential knowledge of a language. The other side of the process of perception and generating of speech in accordance with Chomsky is linguistic performance, which, as he has considered, it is a use of linguistic competence to real speech activity. In doing so Chomsky, however, did not consider them as a mechanisms, but the linguistic competence thought as innate knowledge, in which, the content of this innate knowledge defines the linguistic performance /8/.

But is this so? In our opinion, after A.A.Leontiev we are ready to recognize that such an explanation we cannot accept as appropriate, and we must agree with A.R.Luria, when he writes: "...competence in language as well as performance does not spring up at once and is not an independent phenomenon. It is thought that competence in language is a result of its performance and only in the process of active reflection of reality and of active contact with people by a child results in the understanding of language. There is good reason to believe that the genetic roots of language should be searched...in forms of concrete human activities"/8, 10/.

In the preceding passage of A.R.Luria two essential moments should be noted, which were not considered by N.Chomsky. These are:

1. Interconnection and interdependence of linguistic competence and linguistic performance as dialectical unity of these mechanisms;

2. The nature of the first and the second ability based on activity of these mechanisms as a manifestation of speech as a process.

Separation of these two moments is not an accidental fact, but a result of an approach that is based on the theoretical principles of L.S. Vygotsky and his school, which interprets speech not as a system of speech reactions, but as an active and goal-directed speech activity, determined by certain non-speech tasks, for which the speech activity is realized and which is solved by speech means. The statement or the text is a process of solving of these kinds of tasks and only secondly is a product and result of such task solving /8/.

So, there is, on the one hand goal-directed speech activity, which is determined by non-speech tasks and on the other hand by linguistic competence, which is defined as an ability to generate statements. That is to say, as the ability for creating of their excess, and also linguistic performance, which is considered as the use of a linguistic competence for real speech activity (i.e. taking into the account the infinitive influence on the process of speech at concrete instant of time), as an ability of selection of concrete sentence in concrete situation of communicative contact (by the scheme of previously obtained invariant). It is also the interconnection between these abilities, which would be more properly defined not as subordination, but as dialectical unity of two processes of creation of freedoms (of redundancy of information - its diversity) and the process of their reduction (removal of redundancy of diversity of information) in accordance with the given goal formulated not on the level of speech, but on the level of sense.

In this respect, as in any activity, speech activity is organized in accordance with the goal and task. However in doing so speech activity does not determine some sort of hard scheme of operation, but rather is accomplished in any concrete case as a selection of one among many possible ways (trajectories) of continuation of process of speech. The final product of speech is never given to us from the outset in any concrete form. Speech activity is a creative process and not a process of coding "a sense" of a text /8/.

Moreover the selection of the concrete statement from a reasonably large account of possible statements is performed on a scheme of invariant, which is the representation of a grammar of a language, on the basis of which is fulfilled the speech activity. It may be presumed that the ability of human intelligence for selecting the invariant - the valuable information, is represented in the basic ability of the mind to acquire the "a priori knowledge", described by I. Kant as anticipation. It may be thought, that this fact has lead N.Chomsky astray and led him to think that this knowledge is innate knowledge.

This forces us to admit that the mastering of speech, that is learning of its perception and generation occurs as a dialectical unity of processes of generating the redundancy-diversity of information and its subsequent reduction, that is to say, as a process of organization, of control.

In our work /4/, we recommended to build the technology for creating a program of language learning with respect to the mechanism of generating redundancy of information, and its subsequent reduction. In doing so, the text of learning program we recommend to build as modeling the ability of generating statements and mechanism of presentation of the text we have modeled as its reduction in every concrete case in accordance with the goal - the sense of statement which is set on mastered language. In such a way we a solving the problem of the transfer the valuable information - knowledge - total combination of invariants, which is a representation of a grammar of studied language, that is to say, a set of rules for generating texts.
4. The mechanism of the mind as interface

According to the opinion of evolutionists, the advent of reason was a result of cephalization of living systems. That is to say, the evolutionary improvement of the central nervous system of living beings, the brain. Evolutionary investigations have shown that this improvement preceded after the complication environmental conditions, and was resulted in form of sequential layers as the levels of development of central nervous system evolved one upon the other. The prominent physiologist N.A.Bernstein has called this process "overgrowing" of central nervous system, as if giving to understand that living systems in process of evolution were improving they mechanism of connection with outside world. As we would say now they interface. It is apparent, that this complication of nervous system of living beings proceeded with the intention that they could see farther and better, meaning that they could more precisely prophesy the future. In this sense reason - intellect, as the highest manifestation of a psyche arose as the ability to see even what cannot be seen by the eyes.

This means, and it was noticed long ago /9/, that the process of thinking and the objective world obeyed one and the same laws. Therefore they cannot contradict each other in results. Hence they must be co-coordinated, and connected with each other. That is to say, the law of thinking must correspond with the universal law of evolution of nature and cognition.

As we know, such a universal law of evolution of the objective and spiritual worlds is the dialectics, more precisely the total combinations of laws of dialectics.

It is common knowledge, that more general laws that govern the development of nature, society and thought are the laws of Unity and Conflict of Opposites, the law of Transition from Quantity to Quality, and the law of Negation of the Negation. In them is manifested the basic, fundamental principle of dialectics, which are firmly establishing general connection and interdependence of phenomena. They developments are also fulfilled through the clash of internal and external contradictions. Namely the dialectics demand:

1. Consideration of all components and connection with other objects (that can be selected on the given stage of cognition);
2. Consideration of objects in the process of development.

This development takes place continuously with the passage of time in a way of coming of new and new moments. But if in this coming of the new moments do not present the same what becomes new, then it will be unknown what develops. Hence the development will scatter itself.

Negation of the distinction of moments of becoming results in the destruction of becoming itself, because in becoming one must change. Total negation of identity of distinctive moments of becoming in the same manner eliminates this becoming replacing it with a multitude of motionless points that are not linked with each other. By this means distinction as well as identity of discrete moments is necessary for all sorts of becoming; without them becoming is impossible /10/.

The investigations performed by the author /11/, resulted in formulation of fundamental law of evolution, the most important part of which is the law of control-learning represented above, are proved that the only one process that can realize the process of development is the mechanism of control with feedback.

Only this mechanism can generate the new (thanks to generating the redundancy) as well as the conservation of identity (as reduction this redundancy-diversity on the basis of the invariant) in accordance with the goal of development. In other words, only thanks to it can be realized the basic characteristic of dialectics - the historism, as the reflection of the processes that are developing in the outside world. Thus the mechanism of the mind permanently curries out the process of building of interface with the environment.

L.S.Vygotsky understood and kept this in mind, when he introduced the notion of "the zone of the nearest development". This notion defined the zone of psychic development of a child, which is still not accessible for the child but into which the child is able to penetrate with the help of the adults. The need of the child to penetrate into this zone begets all well-known "why-questioners". The mastering of the zone of the nearest development is nothing but the need of the child to build his zone of stability./11/. This ability was noticed in the mechanism of generating speech as generation of valuable information. As describe N.D.Haruthunova, the subject of an intercourse is always the deviative phenomena, unique events, individualized properties, while the day-to-day activity does not excite the need of communication. Banality is meant by silence, speech always begins, where the order is violate/12/. In other words, speech is always called to bring the human being as a system connected with outside world in ordered state that is to a stable state. So the human being in the process of his development as a result of learning, open up and overcome the environment, what is the essence of the Life, as elevation over the Death.

5. Conclusions

We have demonstrated that phenomena of linguistic competence and linguistic performance are not the
separate mechanisms functioning of speech, but are different sides of dialectical unity of unit of the mechanism of speech realizing the process of learning-control. Precisely this process curried out by the child was described by Russian poet O.Mandel'stam: "It models the experience from the babble and babble drink from the experience". This was recognized by N.Chomsky, when he studied the creativity of children, especially of the youngest language learners. Because by no means do children repeat whole phrases they hear with astonishing degree of logic - to the point that they often produce sentences that are "too logical" such as "Daddy buyed me some candy." The water gets really hot for behaviorists when it comes to correcting children, who not only prove to be creative, but particularly resistant to corrections:

Adult: "You mean, 'Daddy bought me some candy.'"
Child: "Yea, this morning he buyed me some."

Chomsky was convinced that children never receive enough input to produce the right sentence for every situation. It was obvious that they "generate" new sentences. To do so, children master grammar rules by secretion of invariant that no one consciously teaches them and adults themselves find difficult to learn. In this way that is on the ground of such an invariant the human brain is able to generate an infinite number of sentences. Chimpanzees, in contrast, can learn some "sentences" by heart, but can not anticipate the new ones. We believe that they have not appropriate physiological structure for that, because they can only anticipate the visual images.

A Japanese child growing up in Cairo will learn Arabic just as well as Mexican child can learn English. So the sentence "Colorless green ideas sleep furiously" we are recognizing with simplicity because we have a corresponding invariant of sentence structure in our own memory. This invariant is representative of the grammar of language that gives us stability in interaction with the environment /13/. Thus for "deep structure" of Chomsky we oppose the invariant (valuable information) that the human brain separates from many sentences that he has heard formerly, and begins to productively generate on its basis new sentences.

We can definitely say today, that Chomsky's deep structure must be considered as misleading and the grammar beyond semantic is invariant of structure of many affinitive sentences. But we say with confidence now that Chomsky's merit in history of language research is that he explicitly rejected behaviorism, arguing that the reason for studying linguistic structure is the insight it can provide into the nature and organization of the human mind. This is absolutely true.

The result permits us to consider the process of perception and generation of speech in a new fashion and to reject the purely logic-mathematical model of this process and view this process first of all as a process of control by means of creating the controlling interface with the environment. This fact opens a perspective for computer analysis and synthesis of texts and its genuine translations, and what is very important to build very effective interfaces for man-machine systems, to say nothing of building very efficient systems of learning languages /4/.

So the notion of controlling interface allows us to understand that the speech and language are not merely tolls for conveyance of literal meanings of words and sentences, but are a means of linguistic communication. In other words, they are a matching mechanism with the outside environment. A mechanism that matches human with objects to achieve the state of the unequilibrium stability, as a means to create the mechanism of culture - system of dominant control of system of Life on Earth - self-organizing system with minimum waste aimed for overcoming the growth of entropy or death /14/.

6. References


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