Experimental Verification of General Validity of Non-Force (Information) Interaction Formula

Iurii Teslia (✉ dr.teslia@gmail.com)
National Aviation University

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Tesla Iurii

Doctor of engineering science, Full professor

Professor of technology management department at National Aviation University, Kyiv, Ukraine

e-mail: dr.teslia@gmail.com
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Annotation. The work is devoted to the demonstration of the possibility of applying the formulas of information handling obtained in the theory of non-force interaction for the natural language processing. These formulas were obtained in computer experiments in modelling the movement and interaction of material objects by changing the amount of information that triggers this movement. The hypothesis, objective and tasks of the experimental research were defined. The methods and software tools were developed to conduct the experiments. To compare different results of the simulation of the processes in a human brain during speech production, there was a range of methods proposed to calculate the estimate of sequence of fragments of natural language texts including the methods based on linear approximation.

The experiments confirmed that the formulas of information handling obtained in the theory of non-force interaction reflect the processes of language formation. It is shown that the offered approach can successfully be used to create systems of reactive artificial intelligence machines. Experimental and, presented in this work, practical results constitute that the non-force (informational) interaction formulae are generally valid.

1. INTRODUCTION

Information is the basis of a human life. Can it be that it is the source of the Universe’s existence? Can the Universe be digital, computable? Today there is a range of theories that declare this variant of world formation. Particularly, the computer simulation hypothesis of Nick Bostrom [1], or the research of the laws of physics as a cellular automaton by Stephen Wolfram and Nobel laureate Gerard ’t Hooft [2-3]. But, unfortunately, these, as well as other similar theories, have not been proven experimentally yet.

One of these theories is the non-force interaction theory (NFIT). It is based on a computer model in which the source of movement is information that triggers the movement [4-6]. Not only at social, biological or technical level of the matter existence, but also the mechanical movement of any material objects. If information is the basis of the Universe’s existence, it should definitely manifest itself in mechanical movement as movement is a general form of the existence of matter. The NFIT is built on the information-probabilistic interpretation of movement. There are formulae received that correspond to Newton’s classical and Einstein’s relativistic mechanics with one addition that the source of movement is the information. Therefore, during interaction informational contents changes first, which then leads to changes in movement (speaking about mechanical movement, it leads to changes in the direction and speed of movement).

In the article, it is offered to verify the correspondence of the formulae received in the theory of non-force interaction to informational processes of speech production in a human brain by the means of computer experiments. The main question the answer to which is given in the article through experimental research is that probabilities of sequence of letter combinations in the texts in different languages can be received from the formulae of non-force interaction, which in their turn were received from information-probabilistic interpretation of mechanical movement.

If we can confirm it, it will mean that, when forming natural language texts, the processes of interaction in a human brain correspond to the formulae received in the theory of non-force interaction. This, therefore, will prove the universality of these formulae, and therefore, the validity of the results received from the theory of non-force interaction. Moreover, the main aspect is that this will significantly prove the hypothesis of the theory that all interactions in the Nature are caused by informational reasons.
2. PRIMARY RESEARCH MATERIALS

2.1. General information about non-force interaction theory

The theory of non-force (information) interaction gives information-probabilistic interpretation of the laws that describe mechanical movement and immediate interaction of material objects. To do this, one more parameter was introduced into the non-force interaction theory: information that triggers the movement. On the basis of this, the formulae of transformation of information contents of the objects during their interaction were received from the known laws of physics. These formulae were obtained based on the following logical conclusions:

1. The theory of non-force interaction is based on the thesis that each object has a memory that contains information about previous interactions and that motivates it to move. Geometrically, memory is represented by the areas of determining the direction of movement of the object (Fig. 1). The greater the difference in the amount of information that triggers the movement of two objects, the greater the relative velocity of the objects.

2. In the non-force interaction theory physical fields [7] provide information that triggers the movement. Field is not physical, but informational category. It is important what information the field can transfer rather than how it is done. **Physical field is the carrier of information and not the source of forceful action.**

3. The movement of objects is determined not by physical laws, but by their “ability to react correctly” to the existence of other objects and which was formed during 13.8 billion years. In almost 13.8 billion years the matter learned to react to other objects exactly as it does when it changes the direction and velocity of movement during interaction. Physics explains the movement by the constant physical laws of the Nature. However, in the non-force interaction theory the movement is information.

4. We provide information to other people through speech. This information changes (complements) their available information. Such changed information triggers changes in the “movement” (actions) of people. Now, let us use the method of analogies. Physical fields “provide” information to the objects about the existence of other objects. The changed amount of information that triggers the movement, triggers the changes in mechanical movement (direction and velocity).

5. During the interaction of material objects, their amount of information that triggers the movement changes first, which then leads to the changes in their movement.

6. From the known “physical laws” there can be received the laws of change of the amount of information that triggers the movement, during interaction.

7. In the non-force interaction theory, the movement of the object is interpreted by shifts in possible directions (one quantum of space per one quantum of time). The probability of the shift is determined by the amount of information that triggers the movement [4-5]. For a one-dimension movement in direction Z (fig.1) [5].

8. On the figure 1, the formulae that are proposed in the non-force interaction theory [4] are stated to calculate the probability of a shift.

\[
p^+ = \frac{i^+}{i^- + i^+},
\]

\[
p^- = \frac{i^-}{i^- + i^+},
\]

They are based on the geometrical representation of the ranges of definition of the object movement, that are in the object's memory (fig.1).

9. In the NFIT, the difference in the size of the ranges is called the amount of information that triggers the movement and the addition is the awareness:

\[
d = i^+ - i^- - \text{the amount of information that triggers the movement;}
\]

\[
i = i^+ + i^- - \text{awareness.}
\]
10. The amount of information that triggers the movement = information about movement direction collected in interactions = non-force (information) influence on the object as to the choice of this exact movement direction.

Fig. 1 Information-probabilistic model of mechanical movement

11. Awareness = information about movement direction collected in interactions = non-force (information) influence on the object as to possible movement directions.

12. Expected drift velocity (or just velocity) of an object (see Fig. 1) [5]

\[
\vec{V} = (p^+ - p^-) \cdot \vec{c} = (2 \cdot p^+ - 1) \cdot \vec{c}.
\]

where \( \vec{V} \) is expected drift velocity of an object; \( \vec{c} \) is the speed of light in vacuum.

13. The drift velocity of one object regarding the drift velocity of another object is the relative movement velocity.

14. Relative velocity from the formula of relativistic addition of velocities [7] in the information-probabilistic interpretation of mechanical movement looks as follows (using formula 3) [5]:

\[
\Delta \vec{V} = \frac{\vec{V}_2 - \vec{V}_1}{1 - \frac{\vec{V}_1 \cdot \vec{V}_2}{c^2}} \rightarrow \frac{p_2 \cdot (1 - p_1) - p_1 \cdot (1 - p_2)}{p_2 \cdot (1 - p_1) + p_1 \cdot (1 - p_2)} \cdot \vec{c},
\]

where \( \Delta \vec{V} \) is relative velocity of some object \( R_2 \) in relation to the object \( R_1 \); \( p_2 \) is probability of the shift of object \( R_2 \) in the direction in relation to which the difference in velocities is measured; \( p_1 \) is probability of the shift of object \( R_1 \) in the direction in relation to which the difference in velocities is measured; \( c \) is the speed of light in vacuum.

However, from (3) it follows:

\[
\Delta \vec{V} = (2 \cdot \Delta p - 1) \cdot \vec{c},
\]

where \( \Delta p \) is probability of the shift of object \( R_2 \) in relation to object \( R_1 \) in the direction, in relation to which the difference in velocities is measured.

Then, the probability of the shift of object \( R_2 \) which would be “measured” by the observer who is in object \( R_1 \) (shift in the direction “away from the observer”) from (4) and (5) is [1]

\[
\Delta p = \frac{p_2 \cdot (1 - p_1)}{p_2 \cdot (1 - p_1) + p_1 \cdot (1 - p_2)}.
\]

15. In the non-force interaction theory [4], it is shown that the implementation of mechanical movement according to formula (6) is possible only under the condition that the ratio of quantity of actual shifts of all objects one in relation to another will be equal to the ratio of the sizes of definition ranges of motion (see Fig. 1). However, it is only possible in the situation:

\[
i^+ \cdot i^- = const.
\]

Based on the commonly used representation of formulae in relativistic mechanics [7], it is convenient to accept that [4]:

\[
i^+ \cdot i^- = 0.25.
\]
Then from (1), (2) and (7) the connection between the probability of shift in direction \( p \), the amount of information that triggers the movement \( d \) and awareness as to the directions of shift \( i \) in one-dimensional virtual space is defined by the following formulae [1]:

\[
\begin{align*}
    i &= \frac{1}{2\sqrt{p \cdot (1-p)}}; \\
    i &= \sqrt{d^2 + 1}; \\
    d &= \pm \sqrt{i^2 - 1}; \\
    d &= \begin{cases} 
        0.5 \cdot \sqrt{\frac{p}{1-p} + \frac{1-p}{p} - 2, p \geq 0.5} \\
        -0.5 \cdot \sqrt{\frac{p}{1-p} + \frac{1-p}{p} - 2, p < 0.5} 
    \end{cases}; \\
    p &= 0.5 + \frac{d}{2i}.
\end{align*}
\]

(8) (9) (10) (11) (12)

2.2. Velocity and momentum in non-force interaction theory

In the core of the non-force interaction theory, there is a computer model of mechanical movement in which the shift of objects one in relation to another is explained by the difference in the amount of information that triggers the movement, as it is shown in sub-section 2.1. In essence, the non-force interaction theory interprets mechanical movement of material objects “in a new way”. Physical categories, such as velocity and momentum, are interpreted through the information that triggers the movement. Accordingly, physical formulae that include these values are represented in a new way, through the amount of information that triggers the movement. Thus, such their interpretation creates possibility to find analogies and check for conformity with informational interaction of people. Let us look at the following interpretation:

1. Representation of physical formulae through the amount of information that triggers the movement:

   1.1. Applying in (12) formula (3), new representation of velocity formula:

   \[
   \vec{V} = \frac{d}{i} \cdot \vec{c}.
   \]

   (13)

   1.2. Relativistic mass [7]

   \[
   m = \frac{m_0}{\sqrt{1 - \frac{\vec{V}^2}{c^2}}},
   \]

   (14)

   where \( m_0 \) is the mass in the state of rest.

   Applying in (14) formula (13), information-probabilistic interpretation of relativistic mass is obtained [1].

   \[
   m = \frac{m_0}{\sqrt{1 - \frac{\vec{V}^2}{c^2}}} = \frac{m_0}{\sqrt{1 - \frac{d^2 \cdot c^2}{i^2 \cdot c^2}}} = \frac{m_0 \cdot i}{\sqrt{i^2 - d^2}} = m_0 \cdot i.
   \]

   (15)

   1.3. The law of conservation of momentum (quantity of movement). It characterizes mechanical interaction of material objects. It determines that in a closed system the total momentum of all bodies is preserved [8]:

   \[
   \sum_j \vec{P}_j = \text{const},
   \]

   (16)

   where \( \vec{P}_j \) is momentum.

   \[
   \vec{P}_j = m_j \vec{V}_j,
   \]

   (17)
where \( m_j \) is mass; \( \vec{V}_j \) is velocity.

Applying in (17) formulae (13) and (15), it is obtained

\[
\vec{p}_j = m_{0j} \cdot i \cdot \frac{d_j}{i} \cdot \vec{c} = m_{0j} \cdot d_j \cdot \vec{c},
\]

where \( m_{0j} \) is rest mass; \( d_j \) is the amount of information that triggers the movement.

Hence, information-probabilistic interpretation of the law of conservation of momentum can be stated [4]:

\[
\sum_j \vec{p}_j = \sum_j m_{0j} \cdot d_j \cdot \vec{c} = \text{const.}
\]

Out of the fact that in a closed system the total rest mass does not change, the “law of conservation of the amount of information that triggers movement” arises [4]:

\[
\sum_j d_j = \text{const.} \quad (18)
\]

1.4. The difference in velocity is a consequence of the difference in the amount of information that triggers the movement. In the work [4] it is shown that if (13)

\[
\vec{V}_1 = \frac{d_1}{i_1} \cdot \vec{c};
\]

\[
\vec{V}_2 = \frac{d_2}{i_2} \cdot \vec{c};
\]

\[
\Delta \vec{V}_1 = \frac{\Delta d_1}{\Delta i_1} \cdot \vec{c},
\]

where \( \vec{V}_1 \) is the drift velocity of object \( R_1 \); \( \vec{V}_2 \) is the drift velocity of object \( R_2 \); \( d_2 \) is the amount of information that triggers the movement of object \( R_2 \); \( d_1 \) is the amount of information that triggers the movement of object \( R_1 \); \( i_1 \) is awareness of object \( R_1 \),

then from formulae (2)-(4) it is possible to obtain [4]

\[
\Delta d = d_2 i_1 - d_1 i_2, \quad (19)
\]

where \( \Delta d \) is the difference in determination of objects \( R_2 \) and \( R_1 \) in relation to the movement in direction \( Z \).

Having \( d_1 \) and \( \Delta d \) known, it is possible to determine \( d_2 \). See this from (9)

\[
i_1 = \sqrt{d_1^2 + 1};
\]

\[
i_2 = \sqrt{d_2^2 + 1};
\]

\[
\Delta i = \sqrt{\Delta d^2 + 1},
\]

where \( \Delta i \) is the difference in the amount of information that triggers the movement of objects \( R_1 \) and \( R_2 \).

Then, from (9) it follows

\[
d_2 = d_1 \Delta i + i_1 \Delta d. \quad (20)
\]

2. The change in the amount of information that triggers the movement with direct (contact) interaction of objects. When examining this question, the mass of interacting objects will not be looked at, as the change of velocity during direct (contact) interaction depends on the mass and is considered in the calculations provided. Additionally, there is considered a closed system of three objects the mass of which is constant.

2.1. Assuming there is object \( R \) ...

- …moving in direction \( Z \) with velocity \( V_R \) (13)

\[
\vec{V}_R = \frac{d_R}{i_R} \cdot \vec{c},
\]
where $\vec{V}_R$ is the drift velocity of object $R$ in direction $Z$ until collision; $d_R$ is the amount of information that triggers the movement of object $R$ in direction $Z$ until collision; $i_R$ is awareness of object $R$ about movement until collision;

- ... will collide with object $X$ and its velocity will become $V_{RX}$. The change of the amount of information that triggers the movement will correspond to the change of velocity. As it follows from formula (19)

\[
\Delta d_{RX} = d_{RX}i_R - d_Ri_{RX},
\]

where $\Delta d_{RX}$ is the change of the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with object $X$; $i_{RX}$ is awareness of object $R$ about movement after collision with object $X$; $d_{RX}$ the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with object $X$;

- ... will collide with object $Y$ and its velocity will become $V_{RY}$. The change of determination will correspond to the change of velocity. As it follows from formula (19)

\[
\Delta d_{RY} = d_{RY}i_R - d_Ri_{RY},
\]

where $\Delta d_{RY}$ is the change of the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with object $Y$; $i_{RY}$ is awareness of object $R$ about movement after collision with object $Y$; $d_{RY}$ the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with object $Y$;

- ... will collide with both objects $X$ and $Y$ and its velocity will become $V_{RXY}$. From the formula (19) there follows a new amount of information that triggers the movement

\[
\Delta d_{RXY} = d_{RXY}i_R - d_Ri_{RXY},
\]

where $\Delta d_{RXY}$ is the change of the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with objects $X$ and $Y$; $i_{RXY}$ is awareness of object $R$ about movement after collision with objects $X$ and $Y$; $d_{RXY}$ the amount of information that triggers the movement of object $R$ in direction $Z$ after collision with objects $X$ and $Y$.

2.2. Out of information-probabilistic interpretation of the law of conservation of momentum (18) it follows that if two objects interact, the total value of the change of momentum of these objects should equal 0. Only in this case the total momentum does not change. Hence, it can be written

\[
\Delta d_{RX} + \Delta d_{XR} = 0;
\]

\[
\Delta d_{RY} + \Delta d_{YR} = 0,
\]

(22)

where $\Delta d_{XR}$ is the change of the amount of information that triggers the movement of object $X$ in direction $Z$ after colliding with object $R$; $d_{YR}$ is the change of the amount of information that triggers the movement of object $Y$ in direction $Z$ after colliding with object $R$.

Then, for the case of collision of object $R$ with objects $X$ and $Y$; taking into account (18), it can be written as

\[
\Delta d_{RXY} + \Delta d_{XR} + \Delta d_{YR} = 0
\]

Using (22), it can be obtained:

\[
\Delta d_{RXY} = -\Delta d_{XR} - \Delta d_{YR} = \Delta d_{RX} + \Delta d_{RY}.
\]

(23)

From (20) it follows

\[
d_{RXY} = d_R\Delta i_{RXY} + i_R\Delta d_{RXY},
\]

(24)

where $\Delta i_{RXY}$ is the change of awareness of object $R$ about the movement after collision with objects $X$ and $Y$.

From (9) it follows

\[
i_{RXY} = \sqrt{d_{RXY}^2 + 1},
\]

where $i_{RXY}$ is awareness of object $R$ about the movement after collision with objects $X$ and $Y$.

2.3. New probability of shift of object $R$ in direction $Z$ (12)

\[
p_{RXY} = 0.5 + \frac{d_{RXY}}{2 \cdot i_{RXY}},
\]

(25)

where $p_{RXY}$ is the probability of shift of object $R$ in direction $Z$ after colliding with objects $X$ and $Y$. 
If the presented model of transformation of probabilistic movement is really implemented in mechanical movement, its formulae may depict some general laws of our Nature. What if the same formulae are used to transform the information in a human brain? What if they are generally valid? It is the answer to this question that should be found in experiments. To do this, let us first simplify the information-probabilistic interpretation of mechanical movement to the form which makes it possible to solve other problems connected to the existence of on-force interaction.

2.3. Non-force interaction method

The non-violent influence method (NFIM) allows to move from the operation "the amount of information that triggers the movement (mechanical)" to the operation of the amount of information that triggers the reaction (manifestation) (in social, biological or "technical" form of motion of matter).

In the subject field, there are objects that react to non-force influence. There are objects and processes that influence this reaction. The reaction itself can influence the reaction of objects. For instance, the result of a football match is influenced by referees, players, the field condition, audience, etc. However, the result of previous matches also influences the result (through the psychology of players).

The steps of the method:

1. The calculation of the amount of information that triggers the reaction of objects of subject field when non-force influences are absent

\[ \forall R_i \in R, \exists r_{ij} \in R_j, \]

where \( r_{ij} \) is the possible reactions of object \( R_i \); \( R_i \) is the object; \( R \) is the multitude of objects of subject field.

\[ 0 < p(r_{ij}) \leq 1, \sum_j p(r_{ij}) = 1, \]

where \( p(r_{ij}) \) is the unconditional probability of reaction \( r_{ij} \).

Out of (11) it follows:

\[ d(r_{ij}) = \left\{ \begin{array}{ll}
0,5 \cdot \sqrt{\frac{p(r_{ij})}{1-p(r_{ij})} + \frac{1-p(r_{ij})}{p(r_{ij})}} - 2, & p(r_{ij}) \geq 0,5 \\
-0,5 \cdot \sqrt{\frac{p(r_{ij})}{1-p(r_{ij})} + \frac{1-p(r_{ij})}{p(r_{ij})}} - 2, & p(r_{ij}) < 0,5 
\end{array} \right. \]

where \( d(r_{ij}) \) is the amount of information that triggers the reaction \( r_{ij} \).

Out of (8) it follows:

\[ i(r_{ij}) = \frac{1}{2 \sqrt{p(r_{ij}) \cdot (1-p(r_{ij}))}} \]

where \( i(r_{ij}) \) is the awareness about the reaction \( r_{ij} \).

2. The calculation of determination and awareness of reactions of objects of subject field to which the non-force influences are applied

\[ \forall w_k \in W, \exists R_i \in R, r_{ij} \in R_i: p(r_{ij}/w_k) \neq p(r_{ij}), \]

where \( w_k \) are influences; \( p(r_{ij}/w_k) \) is conditional probability of reaction \( r_{ij} \) if to the object \( R_i \) influence \( w_k \) is applied.

Out of (11) it follows:
∀\(w_k \in W, \forall R_i \in R, \forall r_{ij} \in R_i\): 
\[d(r_{ij}/w_k) = \begin{cases} 
0.5 \cdot & \frac{p(r_{ij}/w_k)}{1 - p(r_{ij}/w_k)} + \frac{1 - p(r_{ij}/w_k)}{p(r_{ij}/w_k)} - 2, p(r_{ij}/w_k) \geq 0.5 \\
-0.5 \cdot & \frac{p(r_{ij}/w_k)}{1 - p(r_{ij}/w_k)} + \frac{1 - p(r_{ij}/w_k)}{p(r_{ij}/w_k)} - 2, p(r_{ij}/w_k) < 0.5
\end{cases},\]

where \((r_{ij}/w_k)\) is the determination of the reaction \(r_{ij}\) under the conditional that to the object \(R_i\) the influence \(w_k\) is applied.

Out of (8) it follows:
\[∀\(w_k \in W, \forall R_i \in R, \forall r_{ij} \in R_i\): i'(r_{ij}/w_k) = \frac{1}{2 \sqrt{p(r_{ij}/w_k) \cdot (1 - p(r_{ij}/w_k))}},\]

where \(i'(r_{ij}/w_k)\) is the awareness of the object \(R_i\) about the reaction \(r_{ij}\) under the condition that to it the influence \(w_k\) is applied.

3. The calculation of total non-force influence to the objects from (19) and (23)
\[∀\(w_k \in W, \forall R_i \in R, \forall r_{ij} \in R_i\): ∆d(r_{ij}/W) = \sum_{w_k} d(r_{ij}/w_k) \cdot i'(r_{ij}) - d(r_{ij}) \cdot i'(r_{ij}/w_k),\]

where \(\Delta d(r_{ij}/W)\) is the value of non-force influence on the reaction \(r_{ij}\) of object \(R_i\) that equals to the change in the amount of information that triggers the reaction.

Additional awareness that corresponds to non-force influences (9)
\[∀\(w_k \in W, \forall R_i \in R, \forall r_{ij} \in R_i\): ∆i(r_{ij}/W) = \sqrt{(\Delta d(r_{ij}/W))^2 + 1},\]

where \(\Delta i(r_{ij}/W)\) is additional awareness about non-force influence on the reaction \(r_{ij}\) of object \(R_i\) that corresponds to additional non-force influence.

4. The calculation of a new (after influences) amount of information that triggers the reaction of objects of subject field (24)
\[∀R_i \in R, \forall r_{ij} \in R_i\): d(r_{ij}/W) = \Delta d(r_{ij}/W) \cdot i'(r_{ij}) + d(r_{ij}) \cdot \Delta i(r_{ij}/W), \tag{26}\]

where \(d(r_{ij}/W)\) is a new (after all influence) amount of information that triggers the reaction \(r_{ij}\) of object \(R_i\).

Additional awareness that corresponds to new amount of information that triggers the reaction (9)
\[∀R_i \in R, \forall r_{ij} \in R_i\): i'(r_{ij}/W) = \sqrt{(d(r_{ij}/W))^2 + 1},\]

where \(i'(r_{ij}/W)\) is new (after all influences) awareness about the reaction \(r_{ij}\) of object \(R_i\).

5. The estimate of combined conditional probability of reactions of objects of subject field (12)
\[∀R_i \in R, \forall r_{ij} \in R_i\): \hat{p}(r_{ij}/W) = 0.5 + \frac{d(r_{ij}/W)}{2 \cdot i'(r_{ij}/W)},\]

where \(\hat{p}(r_{ij}/W)\) is the estimate of combined conditional probability of reaction \(r_{ij}\) after all influences.

The initial data of the method are unconditional and individual conditional probabilities of reactions of objects to non-force influences. The resulting data are the estimate of combined conditional probability of reactions. Therefore, the question arises. Why the estimate and not the probability itself? Considering that out of information-probabilistic interpretation of mechanical movement it follows that the result of calculation is the probability of the shift of objects itself. However, in this case the scheme of calculations for any stochastic subject fields is proposed. Thus, these fields can be characterized by such connection between objects and processes when their combinations can have synergetic effect.

Hence, it refers to the estimate of combined conditional probability of reactions and not to the probability itself.
3. RELATED WORKS

Wernicke’s and Broca’s areas are responsible for the speech processes in a human brain. Wernicke's area, which is also called Wernicke's speech area, is one of the two parts of cerebral cortex connected to speech, the other is Broca’s area. Wernicke's area takes part in processing written and spoken language in contrast to Broca’s area, which is responsible for speech production [9].

Wernicke's area supports an important component of speech production which is called phonological search where phonemes subject to articulation and their time order are represented mentally. This process is necessary for all the tasks of speech production including repetition, search of words (for instance, during spontaneous speaking or naming) and reading aloud. Repetition of language means entering the system of phonological search through the system of auditory comprehension of phonemes. Similar mechanism supports reading aloud, except the fact that the entrance to the system of phonological search is through the system of visual perception of letters in ventral occipitotemporal area. The production of communicative speech includes the step of phonological search, during which the concept depicting what the speaker wants to say is received. Then the search of words is made through the reflection of these meanings of words in phonological representations. Thus, in contrast to repetition or reading, entrance to the system of phonological search in these tasks is made through internal semantic system (the meaning of word). This semantic processing network is widely-spread in the cortexes of associations of higher level in temporal, parietal and frontal lobes. The processing of language provides the reflection of the sequences of phonemes (they are perceived in the system of perception of auditory phoneme) in the meanings on words (represented in the semantic system) [10].

Today the researches of the speech production processes are mainly dedicated to the determination of neurobiological features of information interaction in a human brain. For instance, in the work “The Brain Basis of Language Processing: From Structure to Function” [11] the structural and functional neural system that is the basis of sentence processing and how this process evolves with time when the sentence is perceived is described. The authors conduct the overview of short outline of timeline of different subprocesses that constitute the process of sentence processing. Then, the general networking function of speech, which is in the brain cortex, and its neuroanatomical architecture are determined. On the basis of this there were described different processes that happen during processing, such as acoustic and phonological analysis as well as syntax and semantic processes. Also, authors [12-13] argued that speech production includes sensory systems in posterior upper temporal lobe of the left hemisphere and that the interface between perception and movement systems are supported by sensorimotor circuit for the actions of voice routes that is really similar to sensorimotor systems found in the parietal part of primates, and that verbal short-term memory can be understood as integral feature of this sensorimotor circle.

From the position of simulating of speech production processes in a human brain with the aid of mathematical apparatus and computer technologies, nowadays most of the researches are aimed at speech synthesis [14]. The technology of speech synthesis has become the centre of researches in the sphere of intelligent computer. For almost 50 years, the studying of speech synthesis has had considerable development as an interdisciplinary approach [15]. The example of speech synthesis research is the work [16] where there are described concepts of automatic formation of personal digital template of voice to solve the following issues on its basis: computer speech synthesis, continuous speech recognition and identification of a person by voice (three main branches of language technologies). As well as that there is an article [17] where the authors implement and compare the models of identification of spoken language on the basis of deep learning. The authors also use two most modern and popular methods of speech recognition, such as Wav2Vec and SpecAugment, in their classifiers and verify if they are also used in the sphere of speech identification. Among the models that are implemented by authors the classifier of the deep data networks on the basis of X-vector is given the highest rank F1 - 0,91 where target set is composed of five languages. SpecAugment data augmentation method, as it happens, improves the accuracy of classification when it is applied to input mel-spectrograms of CRNN architecture. Even though they receive the accuracy of classification lower than some other methods, Wav2Vec linguistic representations also provide rather promising results.
The researches provided give the answer to the questions how the brain works when it forms or processes the speech. However, despite the considerable number of researches dedicated to the problems of speech production and processing in a human brain, in the process of analysis of modern scientific works not detected were the works that could give the answer to a more important question: why the brain works in this way in the first place? What information laws are in the basis of brain development and structures? How do they function in the process of speech production and processing? If the underlying hypothesis of the NFIT is correct, then in both mechanical movement and the process in a human brain the same laws of non-force (information) interaction should be manifested. Thus, the formulae received from the information-probabilistic interpretation of the mechanical movement should also reflect the processes that are present in a human brain including the ones during speech production and processing. Moreover, in the studied works the correspondence of the existing formulae to the information processes in a human brain connected to speech was not verified, hence the hypothesis of the present research is neither confirmed nor refuted, therefore it requires experimental verification.

4. HYPOTHESIS AND OBJECTIVE OF EXPERIMENTAL RESEARCH

The hypothesis of research: The hypothetical model of non-force interaction created out of the laws of mechanical movement corresponds to the informational processes in a human brain, connected to speech. This is the indication of the laws’ general validity.

Scientific objective of the experiment is to prove the general validity of the non-force interaction formulae through demonstrating the applicability of the formulae received from information-probabilistic interpretation of mechanical movement in relation to the processes of speech production in a human brain.

The practical objective of the experiment is to demonstrate the effectiveness of the method of non-force interaction in relation to the processing of natural language texts, which allows to create scientific-practical tools in the form of methods and algorithms of creation of the artificial intelligence systems that can develop reflexes to non-force influences in the functional environment.

Language is the manifestation of informational processed in a human brain. The idea of experiments is to show through the language that informational processes in a human brain run according to the formulae received in the non-force interaction theory. In fact, the objective of the experiments is to demonstrate the fact that the formulae obtained out of the physical laws “work” at the level of human intellectual activity as well. Particularly, in language. In the experiments it will be checked if it is possible to evaluate combined conditional probability by individual conditional probabilities and unconditional probability of text fragment sequence. Mathematically p(O/XY) needs to be evaluated by p(O), p(O/X), p(O/Y). As it is provided in subsection 2.3 applied to natural language texts.

Such formulation of the problem has also practical value, and in essence it reflects the mechanism of reacting to events (reflexes) of living creatures. In the process of life, each living creature learns how to react to fluences so that ensure its own life-sustaining activity in the best possible way. There is a rule in the core of the reflexes, which says that if X happened, action A is needed. Whereas if Y happened, action B is needed. What is both X and Y happened? In this case, the ability to evaluate combined conditional probability by individual ones can be useful.

If numerical values of speech creation correspond to the formulae received in the theory of non-force interaction, it will mean that intellectual apparatus of a human also uses them when producing speech (and maybe not only speech). In its turn, it means that they most probably are generally valid for the interaction processes in the Nature. Therefore, they can be used to create artificial intelligence systems as well. Is this true? Let us first conduct the experiments, and then look for the answer to this question.

5. METHODOLOGY OF EXPERIMENTAL RESEARCH
All information on experiments is in the database [18].

There are natural language texts in different languages selected. They are the works of William Shakespeare [19] (“English” base), the epic novel of Lev Tolstoy “War and Peace”) [20-23] (“Russian” base), the works of Friedrich Nietzsche, Johann Wolfgang Goethe and Franz Kafka [24-26] (“German” base) and the works of Ukrainian poets [27-29] (“Ukrainian” base).

1. In every sentence, all symbols are rejected except the letters of the corresponding alphabet (the fragments of the such texts are provided in fig.2).

2. Each sentence is divided into consecutive letter combinations (fragments) with the length of L letters (L=1, L=2).

3. The statistical probability of the order of each fragment is calculated, as well as the probability of appearance of a fragment between two other fragments. For the text: \( a_1, a_2, \ldots, a_{i-1}, a_i, a_{i+1}, \ldots, a_n \), the probability

\[
p(a_i) = \frac{n(a_i)}{N_1},
\]

where \( n(a_i) \) is the number of times fragment \( a_i \) appears between other fragments in the text sentences; \( N_1 \) is the total number of fragment combinations present in the sentences of a text; \( p(a_i) \) is the statistic unconditional probability of the sequence of text fragment \( a_i \).

\[
p(a_i/a_{i-1}a_{i+1}) = \frac{n(a_{i-1}, a_i, a_{i+1})}{n(a_{i-1}, a_{i+1})},
\]

where \( n(a_{i-1}, a_i, a_{i+1}) \) is the number of times a fragment combination \( a_{i-1}, a_i, a_{i+1} \) appears in the sentences of a text; \( n(a_{i-1}, a_{i+1}) \) is the number of times fragment combination \( a_{i-1}, \ldots, a_{i+1} \) appears in the sentences of a text; \( p(a_i/a_{i-1}a_{i+1}) \) is the statistical unconditional probability of the sequence of text fragment \( a_i \) if the previous text fragment is \( a_{i-1} \), and the following is \( a_{i+1} \).

| “Russian” Base | “English” Base | “German” Base | “Ukrainian” Base |
|----------------|---------------|---------------|------------------|
| 2165328 letters | 3784551 letters | 1062279 letters | 531926 letters |

Fig.2 The fragments of texts prepared for experiments

4. The statistical probability of sequence of each fragment after another fragment is calculated:

\[
p(a_i/a_{i-1}) = \frac{n(a_{i-1}, a_i)}{n(a_{i-1})},
\]

where \( n(a_{i-1}, a_i) \) is the number of times fragment combination \( a_{i-1}, a_i \) ... appears in the sentences of a text; \( n(a_{i-1}) \) is the number of times a fragment \( a_{i-1} \), ... appears in the sentences of a text; \( p(a_i/a_{i-1}) \)
13

is the statistic conditional probability of sequence of the text fragment $a_i$ if the previous text fragment is $a_{i-1}$.

5. The statistical probability of sequence of each fragment before another fragment is calculated:

$$p(a_i/a_{i+1}) = \frac{n(a_i, a_{i+1})}{n(a_{i+1})},$$

where $n(a_i, a_{i+1})$ is the number of times the combination of fragments $..., a_i, a_{i+1}$ appears in the sentences of a text; $n(a_{i+1})$ is the number of times fragment $..., a_{i+1}$ appears in the sentences of a text; $p(a_i/a_{i+1})$ is the statistical conditional probability of sequence of text fragment $a_i$ if the next fragment is $a_{i+1}$.

6. All the combinations of fragments for which $(a_{i-1}, a_i, a_{i+1}) > 0$ or $n(a_i, a_{i+1}) > 0$ (even if $n(a_{i-1}, a_i, a_{i+1}) = 0$) are recorded in the database.

7. Methods $M_s$ of determination of combined conditional probability are chosen. The value received by such methods will be called estimate of sequence of the text fragments.

$$p_s(a_i/a_{i-1}a_{i+1}),$$

where $p_s(a_i/a_{i-1}a_{i+1})$ is the estimate of combined conditional probability of sequence of text fragment $a_i$ by method $M_s$; $s$ the number of a method.

8. The estimate of combined conditional probability is calculated by using the chosen methods $M_s$.

9. The chosen methods are assessed by the deviation of the estimates of combined conditional probability of sequence of text fragment $a_i$ by method $M_s$ from the conditional probabilities themselves.

10. The results are analysed. If the results are received by the method of non-force interaction are found to be better, it can be stated that the objective of the experiments is achieved.

6. EXPERIMENTAL METHODS

For each combination of fragments, the combined conditional probability estimate is calculated by 9 different methods:

1. By unconditional probability:

$$p_1(a_i/a_{i-1}a_{i+1}) = p(a_i),$$

where $p_1(a_i/a_{i-1}a_{i+1})$ is the estimate of combined conditional probability of sequence of text fragment $a_i$ by its unconditional probability.

2. By conditional probability of the previous fragment:

$$p_2(a_i/a_{i-1}a_{i+1}) = p(a_i/a_{i-1}),$$

where $p_2(a_i/a_{i-1}a_{i+1})$ is the estimate of combined conditional probability of sequence of text fragment $a_i$ by conditional probability of its appearance if the previous text fragment is $a_{i-1}$.

3. By conditional probability of the following fragment:

$$p_3(a_i/a_{i-1}a_{i+1}) = p(a_i/a_{i+1}),$$

where $p_3(a_i/a_{i-1}a_{i+1})$ is the estimate of combined conditional probability of sequence of text fragment $a_i$ by conditional probability of its appearance if the following text fragment is $a_{i+1}$.

4. By the average value of individual conditional probabilities:

$$p_4(a_i/a_{i-1}a_{i+1}) = \frac{p(a_i/a_{i-1}) + p(a_i/a_{i+1})}{2},$$

where $p_4(a_i/a_{i-1}a_{i+1})$ is the estimate of combined conditional probability of sequence of text fragment $a_i$ by the average value of conditional probabilities of its appearance if the previous text fragment is $a_{i-1}$ and the following text fragment is $a_{i+1}$.

5. By weighted sum of individual conditional probabilities (the approximation by linear function using the method of least squares) (hereinafter, Method 1)

$$p_5(a_i/a_{i-1}a_{i+1}) = \alpha_1 \cdot p(a_i/a_{i-1}) + \alpha_2 \cdot p(a_i/a_{i+1}) + \alpha_3,$$

(27)

under the condition that
\[
\sum_{a_i|a_{i-1},a_{i+1}} \left( p_5(a_i/a_{i-1}a_{i+1}) - p(a_i/a_{i-1}a_{i+1}) \right)^2 \rightarrow \min, \tag{28}
\]

where \( p_5(a_i/a_{i-1}a_{i+1}) \) is the estimate of combined conditional probability of sequence of text fragment \( a_i \) by linear approximation of conditional probabilities of its appearance: if the previous text fragment is \( a_{i-1} \); the following text fragment is \( a_{i+1} \); \( \alpha_1, \alpha_2, \alpha_3 \) are approximation coefficients.

6. Taking into account the values of individual conditional probabilities (hereinafter, Method 2).

Also, the approximation by linear function with minimizing of deviation is done:

\[
p_6(a_i/a_{i-1}a_{i+1}) = \beta_1 \cdot \max(p(a_i/a_{i-1}), p(a_i/a_{i+1})) + \beta_2 \cdot \min(p(a_i/a_{i-1}), p(a_i/a_{i+1})) + \beta_3, \tag{29}
\]

under the condition that

\[
\sum_{a_i|a_{i-1},a_{i+1}} \left( p_6(a_i/a_{i-1}a_{i+1}) - p(a_i/a_{i-1}a_{i+1}) \right)^2 \rightarrow \min, \tag{30}
\]

where \( p_6(a_i/a_{i-1}a_{i+1}) \) is the estimate of conditional probability of sequence of text fragment \( a_i \) comparing to the values of individual conditional probabilities: if the previous text fragment is \( a_{i-1} \); the following text fragment is \( a_{i+1} \); \( \beta_1, \beta_2, \beta_3 \) are approximation coefficients.

7. Taking into account the deviation of the second conditional probability from unconditional (hereinafter, Method 3):

\[
p_7(a_i/a_{i-1}a_{i+1}) = \gamma_1 \cdot p(a_i/a_{i-1}) + \gamma_2 \cdot (p(a_i/a_{i+1}) - p(a_i)) + \gamma_3, \tag{31}
\]

under the condition that

\[
\sum_{a_i|a_{i-1},a_{i+1}} \left( p_7(a_i/a_{i-1}a_{i+1}) - p(a_i/a_{i-1}a_{i+1}) \right)^2 \rightarrow \min, \tag{32}
\]

where \( p_7(a_i/a_{i-1}a_{i+1}) \) is the estimate of conditional probability of sequence of text fragment \( a_i \) by linear approximation of deviation of the second conditional probability from unconditional: if the previous text fragment is \( a_{i-1} \); the following text fragment is \( a_{i+1} \); \( \gamma_1, \gamma_2 \) are approximation coefficients.

8. Taking into account the deviation of smaller conditional probability from unconditional (hereinafter Method 4). Let us assume that \( p_i^{\text{max}} \) is maximum. Accordingly, \( p_i^{\text{min}} \) is the smallest of these two values. Then,

\[
p_8(a_i/a_{i-1}a_{i+1}) = \delta_1 \cdot p_i^{\text{max}} + \delta_2 \cdot (p_i^{\text{min}} - p(a_i)) + \delta_3, \tag{33}
\]

under the condition that

\[
\sum_{a_i|a_{i-1},a_{i+1}} \left( p_8(a_i/a_{i-1}a_{i+1}) - p(a_i/a_{i-1}a_{i+1}) \right)^2 \rightarrow \min, \tag{34}
\]

where \( p_8(a_i/a_{i-1}a_{i+1}) \) is the estimate of conditional probability of text fragment \( a_i \) sequence by linear approximation of deviation of a small conditional probability from an unconditional one: if the previous text fragment is \( a_{i-1} \); the following text fragment is \( a_{i+1} \); \( \delta_1, \delta_2 \) are approximation coefficients.

It is possible to invent the multitude of heuristic methods of calculating the estimate of combined conditional probability, not only the ones presented in pp.5-8. The theory of non-force interaction started from the search of such heuristics that could give the best result when processing natural language texts (the experiments were conducted with the aim to create the system of natural speech access to databases in the basis of which was not time-consuming process of syntax, morphological, semantic machine analysis of a text, but rather a reaction to the fragments of texts [30]. Thus, when there was chosen heuristics which could provide the best result, the search of the answer to the question: “why it is like this?” has begun. The solution was found through information-probabilistic interpretation of mechanical movement [4-5].

It is this solution that was put in the basis of the non-force interaction theory.

9. Using the method of non-force interaction, proposed in the theory of non-force interaction (see subsection 2.3). By "reaction" we mean "fragment of text". Regarding the language, in the method...
the following steps of calculation of non-force influences on the process of text formation and
determination of probabilities of sequence of its fragments are implemented:

9.1. The calculation of the influence size. Let us determine the amount of information that triggers
a piece of text (11)

\[
0 < p(a_i) < 1; 0 < p(a_i/a_{i-1}) < 1; 0 < p(a_i/a_{i+1}) < 1;
\]

\[
d(a_i) = \begin{cases}
0.5 \cdot \frac{p(a_i)}{1 - p(a_i)} + \frac{1 - p(a_i)}{p(a_i)} - 2, & p(a_i) \geq 0.5 \\
-0.5 \cdot \frac{p(a_i)}{1 - p(a_i)} + \frac{1 - p(a_i)}{p(a_i)} - 2, & p(a_i) < 0.5
\end{cases};
\]

\[
d(a_i/a_{i-1}) = \begin{cases}
0.5 \cdot \frac{p(a_i/a_{i-1})}{1 - p(a_i/a_{i-1})} + \frac{1 - p(a_i/a_{i-1})}{p(a_i/a_{i-1})} - 2, & p(a_i/a_{i-1}) \geq 0.5 \\
-0.5 \cdot \frac{p(a_i/a_{i-1})}{1 - p(a_i/a_{i-1})} + \frac{1 - p(a_i/a_{i-1})}{p(a_i/a_{i-1})} - 2, & p(a_i/a_{i-1}) < 0.5
\end{cases};
\]

\[
d(a_i/a_{i+1}) = \begin{cases}
0.5 \cdot \frac{p(a_i/a_{i+1})}{1 - p(a_i/a_{i+1})} + \frac{1 - p(a_i/a_{i+1})}{p(a_i/a_{i+1})} - 2, & p(a_i/a_{i+1}) \geq 0.5 \\
-0.5 \cdot \frac{p(a_i/a_{i+1})}{1 - p(a_i/a_{i+1})} + \frac{1 - p(a_i/a_{i+1})}{p(a_i/a_{i+1})} - 2, & p(a_i/a_{i+1}) < 0.5
\end{cases},
\]

where \( d(a_i) \) is the amount of information that triggers a piece of text \( a_i \); \( d(a_i/a_{i-1}) \) is the amount of
information that triggers a piece of text \( a_i \) after fragment \( a_{i-1} \); \( d(a_i/a_{i+1}) \) is the amount of information that
triggers a piece of text \( a_i \) before fragment \( a_{i+1} \).

9.2. Let us calculate the difference in the determination (amount of information) by applying
formula (9) in (19)

\[
\Delta d(a_i/a_{i-1}) = d(a_i/a_{i-1}) \cdot \sqrt{d(a_i)^2 + 1 - d(a_i)} \cdot \sqrt{d(a_i/a_{i-1})^2 + 1};
\]

\[
\Delta d(a_i/a_{i+1}) = d(a_i/a_{i+1}) \cdot \sqrt{d(a_i)^2 + 1 - d(a_i)} \cdot \sqrt{d(a_i/a_{i+1})^2 + 1},
\]

where \( \Delta d(a_i/a_{i-1}) \) is the size of influence which appears in the process of production of fragment \( a_{i-1} \)
on the probability of fragment \( a_i \) as the following fragment (non-force influence of a human brain on
the presence of fragment \( a_i \) when creating fragment \( a_{i-1} \)); \( \Delta d(a_i/a_{i+1}) \) is the size of influence which
appears in the process of production of fragment \( a_{i+1} \) on the probability of production of fragment \( a_i \) as
the previous fragment (the non-force influence of a human brain on the presence of fragment \( a_i \) when
creating fragment \( a_{i+1} \)).

9.3. The non-force influence on the appearance of text fragment \( a_i \) (23):

\[
\Delta d(a_i/a_{i-1}a_{i+1}) = \Delta d(a_i/a_{i-1}) + \Delta d(a_i/a_{i+1}),
\]

where \( \Delta d(a_i/a_{i-1}a_{i+1}) \) is a combined additional influence that appears in the process of production of
fragments \( a_{i-1} \) and \( a_{i+1} \) and which influences the possibility of fragment \( a_i \) being formed next.

9.4. New determination of the amount of information that triggers a piece of text \( a_i \) (from formulae
9 and 26):

\[
d(a_i/a_{i-1}a_{i+1}) = d(a_i) \cdot \sqrt{(\Delta d(a_i/a_{i-1}a_{i+1})^2 + 1) + \Delta d(a_i/a_{i-1}a_{i+1}) \cdot (\Delta d(a_i)^2 + 1),
\]

where \( d(a_i/a_{i-1}a_{i+1}) \) is the amount of information that triggers a piece of text \( a_i \) taking into account
non-force influence.

9.5. The estimate of probability of fragment \( a_i \) presence (after both influences) (12):

\[
p_0(a_i/a_{i-1}a_{i+1}) = 0.5 + \frac{d(a_i/a_{i-1}a_{i+1})}{2 \cdot \sqrt{(d(a_i/a_{i-1}a_{i+1})^2 + 1)}},
\]

(35)
where \( p_0(a_i/a_{i-1}a_{i+1}) \) is the estimate of conditional probability of text fragment \( a_i \) sequence, through non-force influence on the possibility of fragment \( a_i \) production, which appears in the process of producing fragments \( a_{i-1} \) and \( a_{i+1} \).

7. METHODS’ EFFECTIVENESS EVALUATION CRITERIA

The effectiveness of the methods is to be evaluated by the following criteria:

1. Standard deviation of the estimate of combined conditional probability, received by method \( M_s \) from statistical combined conditional probability of text fragment sequence:

\[
\sigma_s = \sqrt{\frac{\sum_{i=2}^{N_s} \left[ p_s(a_i/a_{i-1}a_{i+1}) - p(a_i/a_{i-1}a_{i+1}) \right]^2}{N_s}},
\]

(36)

where \( N_s \) is quantity of text fragments about which the estimate of combined conditional probability is calculated by method \( M_s \); \( p_s(a_i/a_{i-1}a_{i+1}) \) is estimate of combined conditional probability of text fragment sequence calculated by method \( M_s \); \( p(a_i/a_{i-1}a_{i+1}) \) is combined conditional probability of text fragment sequence; \( \sigma_s \) is standard deviation of estimate of combined conditional probability of text fragment sequence received by method \( M_s \) from statistical combined conditional probabilities.

The advantage of non-force interaction method over the other will be calculated by dividing the difference between deviation of NFIM and the smallest deviation of other methods by deviation of NFIM and multiplying by 100%:

\[
Y_\sigma = \frac{\sigma_9 - \max_{1 \leq i \leq 8} \sigma_i}{\sigma_9} \cdot 100\%,
\]

(37)

where \( Y_\sigma \) is the advantage of non-force interaction method in standard deviation of estimate of combined conditional probability of text fragment sequence.

2. The percentage of correctly predicted text fragments:

\[
\mu_s = \frac{\sum_{a_{i-1}a_{i+1}} \left[ \frac{n(a_i/a_{i-1}a_{i+1})}{\max_{a_i} p_s(a_i/a_{i-1}a_{i+1})} \right] \cdot 100\%}{\sum_{a_{i-1}a_{i+1}} n(a_{i-1}a_{i+1})'},
\]

(38)

where \( \mu_m \) is percentage of correct predictions of text fragment sequence made by \( M_i \); \( p_s(a_i/a_{i-1}a_{i+1}) \) is estimate of combined conditional probability of text fragment \( a_i \) sequence made by method \( M_i \); \( n(a_i/a_{i-1}a_{i+1}) \) is the quantity of letter combinations where the combination of fragments \( a_{i-1}a_i\) is present; \( n(a_{i-1}a_{i+1}) \) is the quantity of letter combinations where the combination of fragments \( a_{i-1}<\text{any fragment}>a_{i+1} \) is present.

The advantage of non-force interaction method over the others will be calculated by dividing the difference between the percentage (quantity) of correctly predicted text fragments, made by NFIM and the biggest percentage (quantity) of text fragments predicted correctly by other methods by percentage (quantity) of text fragments predicted correctly by NFIM and multiplying by 100%:

\[
Y_\mu = \frac{\mu_9 - \max_{1 \leq i \leq 8} \mu_i}{\mu_9} \cdot 100\%,
\]

(39)

where \( Y_\mu \) is the advantage of non-force interaction method in predicting text fragments appearance.

3. Standard deviation of the rank of estimate of combined conditional probability received by method \( M_s \) from the range of nonzero statistical combined conditional probability of text fragment sequence:

\[
V_s = \sqrt{\frac{\sum_{i=1}^{N_s} \left[ u_s(a_i/a_{i-1}a_{i+1}) - u(a_i/a_{i-1}a_{i+1}) \right]^2}{N_s}},
\]

(40)

under the condition that

\[ p(a_i/a_{i-1}a_{i+1}) > 0, \]

where \( V_s \) is standard deviation of the rank of estimate of combined conditional probability of text fragment sequence from the rank of statistical conditional probability in method \( M_s \); \( u_s(a_i/a_{i-1}a_{i+1}) \) is rank of estimate of combined conditional probability of text fragment sequence received by method \( M_s \);
\( p(a_i/a_{i-1}a_{i+1}) \) is combined conditional probability of text fragment sequence; \( u(a_i/a_{i-1}a_{i+1}) \) is rank of combined conditional probability of text fragment sequence.

As a rank, an ordinate number in the ordered range of probabilities of text fragment sequence is understood. For the sequence:

\[
p(a_{i_1}/a_{i-1}a_{i+1}) > p(a_{i_2}/a_{i-1}a_{i+1}) > \ldots > p(a_{i_f}/a_{i-1}a_{i+1}) > \ldots > p(a_{i_k}/a_{i-1}a_{i+1}),
\]

the rank of conditional probabilities will be the following:

\[
\begin{align*}
    u(a_{i_1}/a_{i-1}a_{i+1}) &= 1; \\
    u(a_{i_2}/a_{i-1}a_{i+1}) &= 2; \\
    &\ldots \\
    u(a_{i_f}/a_{i-1}a_{i+1}) &= f; \\
    &\ldots \\
    u(a_{i_k}/a_{i-1}a_{i+1}) &= k.
\end{align*}
\]

For the sequence received by method \( M_s \):

\[
p_s(a_{j_1}/a_{i-1}a_{i+1}) > p_s(a_{j_2}/a_{i-1}a_{i+1}) > \ldots > p_s(a_{j_r}/a_{i-1}a_{i+1}) > \ldots > p_s(a_{j_k}/a_{i-1}a_{i+1}),
\]

the rank of estimates of combined conditional probabilities will be the following:

\[
\begin{align*}
    u_s(a_{j_1}/a_{i-1}a_{i+1}) &= 1; \\
    u_s(a_{j_2}/a_{i-1}a_{i+1}) &= 2; \\
    &\ldots \\
    u_s(a_{j_r}/a_{i-1}a_{i+1}) &= r; \\
    &\ldots \\
    u_s(a_{j_k}/a_{i-1}a_{i+1}) &= k.
\end{align*}
\]

This criterion is chosen because the estimate of combined conditional probability received by any method and the probability itself do not coincide. This is caused, in the first place, by the synergetic effect. That is by one more direction of evaluation was chosen the ranking of probability estimates and probabilities themselves of text fragments. How each method allows to rank fragments correctly according to the frequency of their appearance in a natural text. As well as the criterion of prediction, this one is really important and often used in artificial intelligence systems.

The advantage of non-force interaction method over the others will be calculated by diving the difference between the deviation of NFIM and the smallest deviation of other methods by the deviation of NFIM and multiplying by 100%:

\[
Y_V = \frac{V_9 - \max_{1\leq i\leq 8} V_i}{V_9} \cdot 100%,
\]

where \( Y_V \) is the advantage of non-force interaction method in standard deviation of the rank of estimate of combined conditional probability from the rank of combined conditional probability of text fragment sequence.

Methods provided in pp.5-8 can form the estimate of combined conditional probability which is more than 1. To eliminate this, the author used the normalizing, which is division by the biggest value of result. However, the experiments showed that in this case the deviation of combined conditional probability estimates from the conditional probability of text fragment sequence itself has increased. In order not to be “blamed” in lowering the results of approximation methods, below there are non-normalized values of approximation methods are compared to non-force interaction method.

As to the criteria of the best prediction and the deviation in ranks, normalizing does not influence the result. Since for predicting the highest estimate is chosen (and normalizing does not change this choice), and ranking decides on the estimate sequence (normalizing does not change it either).

8. SOFTWARE TOOLS

To implement the methodology stated in section 5, there was developed a program “Experiments on NFIT” in VBA Access. It contains the interpreter of the texts (implements pp.1-2 of section 5),
statistics formation module (pp.3-5 of section 5), module to calculate estimates of combined conditional probability by different methods (pp.6-8 of section 5), module of results analysis and display (p.9-10 of section 5).

Time spent on conduction of experiments connected with the application of provided methodology to four natural language texts on a desktop computer (PC) is approximately 200 hours. Generalized algorithm of calculation of estimates of combined conditional probabilities of text fragment sequence includes the following points:

1. Transformation of the text into the set of 1- and 2-letter sequenced fragments.
2. Calculation of statistical characteristics of a text (unconditional and conditional probabilities of text fragment sequence).
3. Setting of the parameters of calculation (random or input text, with or without reference to unconditional probability of current text fragment sequence, with division of the text into educating and check samples, merger of texts, etc.)
4. Calculation of coefficients in approximation equations.
5. Calculation of estimates of combined conditional probability by all methods.
6. Evaluation of results and formation of reports.
7. Display of results.

To make the algorithm of calculation more understandable, let us consider the example of calculation of estimates of combined conditional probability by different methods.

9. THE EXAMPLE OF CALCULATION (FRAGMENT OF “ENGLISH” BASE)

Let us consider three two-letter fragments: \( a_{t-1} = \text{“ab”}; a_t = \text{“le”}; a_{t+1} = \text{“in”}. \)

\[
\begin{align*}
\text{p(“le”)} &= 0.006458; \\
\text{p(“le”/“ab”)} &= 0.233333; \\
\text{p(“le”/“in”)} &= 0.002379; \\
\text{p(“le”/“ab”“in”)} &= ?
\end{align*}
\]

For each combination of fragments, the calculation of estimate of combined conditional probability is made by the methods provided above. The results are summarized in table 1. What conclusions can be made:

1. The best method for this combination of fragments if the one based on the results received in the non-force interaction theory.
2. None of the methods gives exact value of combined conditional probability. If the intellectual apparatus of a human had also developed for 13.8 billion years, the regularity in formation of text fragments would exactly correspond to the formulae interpreted from the laws of mechanical movement?!

It is a joke, of course. The peculiarity of human intellectual apparatus is the implementation of synergistic features of a language. The combination of fragments, by contents, is considerably bigger than their total sum! However, the fact that the non-force interaction theory provides the biggest approximation even in this example requires a more serious confirmation, as it is wrong to judge by one fragment. Within the experiment, there were processed the statistics by all fragments in the selected works of writing [19-29]. Let is consider the results of the conducted experiments.
### Table 1
Results of estimating of combined conditional probability of appearance of fragment “le” with neighbouring fragments “ab” and “in” in “English” base made by different methods

| №  | Name of method                                      | Formula | Value            | Difference from actual value | Difference rank |
|----|-----------------------------------------------------|---------|------------------|------------------------------|-----------------|
| 1. | By unconditional probability                       | \( p("le") \) | 0.006458        | -0.18585                     | 8               |
| 2. | By conditional probability of a previous fragment  | \( p("le"/"ab") \) | 0.233333   | 0.041025                      | 5               |
| 3. | By conditional probability of a following fragment | \( p("le"/"in") \) | 0.002379   | -0.189929                     | 9               |
| 4. | By mean probability                                | \( \frac{p("le"/"ab") + p("le"/"in")}{2} \) | 0.117856 | -0.07445                      | 7               |
| 5. | Method 1. Coefficients: \( \alpha_1 = 0.664; \alpha_2 = 0.714; \alpha_3 = -0.001 \) | \( \alpha_1 \cdot p("le"/"ab") + \alpha_2 \cdot p("le"/"in") + \alpha_3 \) | 0.155632 | -0.03668                      | 4               |
| 6. | Method 2. Coefficients: \( \beta_1 = 0.484; \beta_2 = 3.562; \beta_3 = -0.002 \) | \( \beta_1 \cdot p("le"/"ab") + \beta_2 \cdot p("le"/"in") + \beta_3 \) | 0.119407 | -0.0729                       | 6               |
| 7. | Method 3. Coefficient: \( \gamma_1 = 0.707; \gamma_2 = 0.743; \gamma_3 = 0.001 \) | \( \gamma_1 \cdot p("le"/"ab") + \gamma_2 \cdot (p("le"/"in") - p(le)) + \gamma_3 \) | 0.167734 | -0.02457                      | 3               |
| 8. | Method 4. Coefficient: \( \delta_1 = 0.682; \delta_2 = 1.990; \delta_3 = 0.004 \) | \( \delta_1 \cdot p("le"/"ab") + \delta_2 \cdot (p("le"/"in") - p(le)) + \delta_3 \) | 0.167867 | -0.02444                      | 2               |
| 9. | Non-force interaction method                       |         |                  |                              |                 |
|    | 1. Calculation of influence size \( d("le") \)   |         |                  |                              |                 |
|    | \( \Delta d("le"/"ab") \)                         |         |                  |                              |                 |
|    | \( \Delta d("le"/"in") \)                         |         |                  |                              |                 |
|    | 2. Combined additional influence \( \Delta d("le"/"ab"+"in") \) | \( \Delta d("le"/"ab") + \Delta d("le"/"in") \) | 0.546599 | -0.01171                      | 1               |
|    | 3. New quantity of information about the presence of fragment "le" \( d("le"/"ab"+"in") \) | \( d("le") \) | -6.161437    | 3.348290                      |                 |
|    | 4. Estimate of probability of fragment presence (after both influences). \( d("le"/"ab"+"in") \) | \( d("le") \) | -0.522639   | 2.825651                      |                 |
10. RESULTS OF EXPERIMENTS

Having set input texts (section 5) for the developed program (section 8) and calculated unconditional and conditional probabilities of appearance of fragments (letter combinations) of texts of one- and two-letter length, there were formed statistical tables, in accordance to the chosen criteria (section 7).

Unconditional statistical probabilities for 1-letter fragments are shown in tables 2-5. For 2-letter fragments such tables contain 941 records (“Russian” base), 609 (“English base”), 956 (“Ukrainian” base), 709 (“German” base).

Let us consider the results received.

| Fragment | Frequency | Probability |
|----------|-----------|-------------|
| а        | 175827    | 0,083292    |
| б        | 37245     | 0,017644    |
| в        | 98741     | 0,046775    |
| г        | 42105     | 0,019946    |
| д        | 65559     | 0,031056    |
| е        | 176940    | 0,083819    |
| ж        | 23074     | 0,010931    |
| з        | 37060     | 0,017556    |
| и        | 145085    | 0,068729    |
| й        | 23616     | 0,011187    |
| к        | 71762     | 0,033995    |
| л        | 108142    | 0,051229    |
| м        | 63055     | 0,029870    |
| н        | 138196    | 0,065466    |
| о        | 248121    | 0,117539    |
| п        | 56211     | 0,026628    |
| р        | 95332     | 0,045160    |
| с        | 114635    | 0,054304    |
| т        | 125962    | 0,059670    |
| у        | 57720     | 0,027343    |
| ф        | 4385      | 0,002077    |
| х        | 18300     | 0,008669    |
| ц        | 7694      | 0,003645    |
| ш        | 20128     | 0,009535    |
| щ        | 6390      | 0,003027    |
| ъ        | 923       | 0,000437    |
| ы        | 41442     | 0,019632    |
| ь        | 41546     | 0,019681    |
| э         | 6409      | 0,003036    |
| ю         | 12849     | 0,006087    |
| я         | 46515     | 0,022035    |

Table 2

Frequency of appearance of Russian alphabet letters in “Russian” base

| Fragment | Frequency | Probability |
|----------|-----------|-------------|
| a        | 284554    | 0,07714     |
| b        | 58963     | 0,015984    |
| c        | 84602     | 0,022935    |
| d        | 143045    | 0,038778    |
| e        | 433237    | 0,117446    |
| f        | 77559     | 0,021025    |
| g        | 65513     | 0,01776     |
| h        | 233002    | 0,063164    |
| i        | 250734    | 0,067971    |
| j        | 4347      | 0,001178    |
| k        | 32997     | 0,008945    |
| l        | 165938    | 0,044984    |
| m        | 107653    | 0,029184    |
| n        | 238352    | 0,064615    |
| o        | 311075    | 0,084329    |
| p        | 54977     | 0,014904    |
| q        | 3090      | 0,000838    |
| r        | 232522    | 0,063034    |
| s        | 238711    | 0,064712    |
| t        | 319496    | 0,086612    |
| u        | 127585    | 0,034587    |
| v        | 36926     | 0,01001     |
| w        | 86719     | 0,023509    |
| x        | 5223      | 0,001416    |
| y        | 90381     | 0,024501    |
| z        | 1616      | 0,000438    |

Table 3

Frequency of Latin letter appearance in “English” base
Table 4

Frequency of appearance of German alphabet letters in “German” base

| Fragment | Frequency | Probability |
|----------|-----------|-------------|
| a        | 49004     | 0.050259    |
| ä        | 4965      | 0.005092    |
| b        | 17785     | 0.018241    |
| c        | 36940     | 0.037886    |
| d        | 44264     | 0.045398    |
| e        | 149403    | 0.15323     |
| f        | 17020     | 0.017456    |
| g        | 30778     | 0.031566    |
| h        | 61621     | 0.063199    |
| i        | 76184     | 0.078135    |
| j        | 2546      | 0.002611    |
| k        | 11361     | 0.011652    |
| l        | 39694     | 0.040711    |
| m        | 27415     | 0.028117    |
| n        | 92783     | 0.09516     |
| o        | 26590     | 0.027271    |
| ö        | 3229      | 0.003312    |
| p        | 7638      | 0.007834    |
| q        | 283       | 0.00029     |
| r        | 65295     | 0.066968    |
| s        | 64256     | 0.065902    |
| ß         | 3486      | 0.003575    |
| t        | 60144     | 0.061685    |
| u        | 37803     | 0.038771    |
| ü        | 6380      | 0.006543    |
| v        | 7429      | 0.007619    |

Table 5

Frequency of appearance of Ukrainian alphabet letters in “Ukrainian” base

| Fragment | Frequency | Probability |
|----------|-----------|-------------|
| а        | 35710     | 0.09545     |
| б        | 7862      | 0.02101     |
| в        | 16595     | 0.04436     |
| г        | 6644      | 0.01776     |
| д        | 12866     | 0.03439     |
| е        | 20693     | 0.05531     |
| є        | 2333      | 0.00624     |
| ж        | 3885      | 0.01038     |
| з        | 7913      | 0.02115     |
| и        | 25255     | 0.06750     |
| і        | 15511     | 0.04146     |
| й        | 1914      | 0.00512     |
| й        | 6100      | 0.01630     |
| к        | 12404     | 0.03315     |
| л        | 17528     | 0.04685     |
| м        | 12277     | 0.03281     |
| н        | 20282     | 0.05421     |
| о        | 36527     | 0.09763     |
| п        | 9957      | 0.02661     |
| р        | 15599     | 0.04169     |
| с        | 16822     | 0.04496     |
| т        | 21300     | 0.05693     |
| у        | 12561     | 0.03357     |
| ф        | 120       | 0.00032     |
| х        | 4285      | 0.01145     |
| ц        | 1831      | 0.00489     |
| ч        | 5345      | 0.01429     |
| ш        | 2862      | 0.00765     |
| щ        | 1806      | 0.00483     |
| й        | 6855      | 0.01832     |
| ю        | 4348      | 0.01162     |
| я        | 8146      | 0.02177     |
Experiment 1. Calculation of approximation coefficients.

For each text, there are determined approximation coefficients that correspond to conditions (28), (30), (32), and (34). Approximation coefficients are stated in table 6. As it can be seen from table 6, these coefficients are different enough for the texts in different languages. This means that it is impossible to find such linear approximation which will be optimal for different texts in different languages.

Table 6

| Base          | $a_1$ | $a_2$ | $b_1$ | $b_2$ | $b_3$ | $\chi_1$ | $\chi_2$ | $\chi_3$ | $\delta_1$ | $\delta_2$ | $\delta_3$ |
|---------------|-------|-------|-------|-------|-------|-----------|-----------|-----------|-------------|-------------|-------------|
| "Russian"     | 0.613 | 0.588 | -0.006| 0.292 | 1.592 | -0.005    | 0.741     | 0.669     | 0.008       | 0.663       | 1.085       | 0.018       |
|               | 0.663 | 0.673 | -0.001| 0.472 | 4.293 | -0.002    | 0.692     | 0.689     | 0.000       | 0.644       | 2.367       | 0.004       |
| "German"      | 0.785 | 0.527 | -0.011| 0.529 | 1.130 | -0.011    | 0.915     | 0.684     | 0.003       | 0.815       | 1.006       | 0.010       |
|               | 0.723 | 0.708 | -0.002| 0.496 | 3.017 | -0.002    | 0.777     | 0.760     | 0.000       | 0.720       | 1.948       | 0.003       |
| "Ukrainian"   | 0.720 | 0.618 | -0.011| 0.374 | 1.419 | -0.007    | 0.857     | 0.786     | 0.004       | 0.746       | 1.226       | 0.016       |
|               | 0.782 | 0.813 | -0.002| 0.498 | 4.516 | -0.002    | 0.829     | 0.851     | 0.000       | 0.741       | 3.074       | 0.004       |
| "English"     | 0.769 | 0.600 | -0.014| 0.521 | 1.186 | -0.015    | 0.914     | 0.715     | 0.003       | 0.809       | 1.040       | 0.012       |
|               | 0.664 | 0.714 | -0.001| 0.484 | 3.562 | -0.002    | 0.707     | 0.743     | 0.001       | 0.682       | 1.990       | 0.004       |

Experiment 2. Determination of standard deviation of combined conditional probability estimate from statistical combined conditional probability of text fragment sequence.

Evaluation criterion: standard deviation (36).

Processing of texts by the program “Experiments by NFIT” allowed to receive the integral values of deviation of calculated combined conditional probability estimates (36) (table 7). As it can be seen from table 7, non-force interaction method gives smaller deviation of probability estimate from its statistical value than other methods in all the texts except “Russian” base (one-letter fragments).

Table 7

| Base         | L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) (37) |
|--------------|---|------------------------------|-----------------|-----------------|---------------------|----------|----------|----------|----------|------|--------------------------|
| "Russian"   | 1 | 0.09457                      | 0.08879         | 0.09018         | 0.08228             | 0.08170  | 0.07842  | 0.08182  | 0.08117  | 0.08909 | -3.05                   |
|              | 2 | 0.04313                      | 0.04236         | 0.04227         | 0.04121             | 0.04107  | 0.04028  | 0.04106  | 0.04073  | 0.03951 | 1.96                     |
| "German"    | 1 | 0.10891                      | 0.09320         | 0.10388         | 0.08973             | 0.08714  | 0.08690  | 0.08559  | 0.08596  | 0.08142 | 5.12                     |
|              | 2 | 0.05479                      | 0.05296         | 0.05322         | 0.05148             | 0.05110  | 0.05019  | 0.05102  | 0.05058  | 0.04839 | 3.71                     |
| "Ukrainian" | 1 | 0.08289                      | 0.07339         | 0.07588         | 0.06849             | 0.06694  | 0.06486  | 0.06544  | 0.06455  | 0.06204 | 4.06                     |
|              | 2 | 0.04803                      | 0.04731         | 0.04715         | 0.04662             | 0.04637  | 0.04561  | 0.04634  | 0.04589  | 0.04491 | 1.56                     |
| "English"   | 1 | 0.10037                      | 0.08645         | 0.09298         | 0.08129             | 0.07845  | 0.07769  | 0.07768  | 0.07787  | 0.07466 | 4.05                     |
|              | 2 | 0.04393                      | 0.04292         | 0.04265         | 0.04149             | 0.04127  | 0.04049  | 0.04124  | 0.04092  | 0.03948 | 2.55                     |

Note: The best results are highlighted.
Having applied Fisher distribution to values stated in table 7, it is received a confirmation of statistical hypotheses about exceedance of variance of other methods over the variance of non-force interaction method [31] (excluding Russian text with singular length of fragments) with significance level of $\alpha=0.01$ (table 8). In table 8, for comparison it is considered the deviation variance of combined conditional probability estimate from combined conditional probability itself received by NFIM and the smallest deviation variance of combined conditional probability estimate from combined conditional probability itself received by other methods. The confirmation of these hypotheses indicates that for other methods (which have a bigger deviation with the same degrees of freedom) they will be confirmed too.

Table 8

| Base        | $L$ | $\min \sigma_i^2$ | $\sigma_9$ | $\min \sigma_i^2$ | $\sigma_9^2$ | $F_{n,\alpha} = \frac{\min \sigma_i^2}{\sigma_9^2}$ | $n$ | $F_{0.01;\alpha;\alpha}$ | Confirmed hypothesis |
|-------------|-----|-------------------|-------------|-------------------|-------------|---------------------------------|-----|------------------------|----------------------|
| “Russian”   | 1   | 0.07842           | 0.0809      | 0.00615           | 0.006545    | 1.064249*                       | 32758| 1.02604                | $\min \sigma_i^2 < \sigma_9^2$ |
|             | 2   | 0.04028           | 0.03951     | 0.001622          | 0.001561    | 1.039357                        | 65238532| 1.00058                | $\min \sigma_i^2 > \sigma_9^2$ |
| “German”    | 1   | 0.08596           | 0.08142     | 0.007389          | 0.006629    | 1.11463                         | 23349| 1.03092                | $\min \sigma_i^2 > \sigma_9^2$ |
|             | 2   | 0.05019           | 0.04839     | 0.002519          | 0.002342    | 1.075779                        | 21284121| 1.00101                | $\min \sigma_i^2 > \sigma_9^2$ |
| “Ukrainian” | 1   | 0.06455           | 0.06204     | 0.004167          | 0.003849    | 1.082552                        | 32178| 1.02628                | $\min \sigma_i^2 > \sigma_9^2$ |
|             | 2   | 0.04561           | 0.04491     | 0.00208           | 0.002017    | 1.031416                        | 42253549| 1.00072                | $\min \sigma_i^2 > \sigma_9^2$ |
| “English”   | 1   | 0.07768           | 0.07466     | 0.006034          | 0.005574    | 1.082536                        | 16783| 1.03657                | $\min \sigma_i^2 > \sigma_9^2$ |
|             | 2   | 0.04049           | 0.03948     | 0.001639          | 0.001559    | 1.05182                         | 40791720| 1.00073                | $\min \sigma_i^2 > \sigma_9^2$ |

* - there is a hypothesis considered about exceedance of standard deviation received by non-force interaction method over the smallest standard deviation received by other methods.

However, there is one exception, which is the Russian text. As it is shown in the results of additionally conducted experiments with other texts in Russian (“Anna Karenina” by Lev Tolstoy and “Master and Margarita” by Mikhail Bulgakov), this regularity is preserved. There was a separate research conducted, which showed that the main reason is four words that happen often and contain letter which almost do not appear in other combinations. Thus, in the word “всё” the probability of letter “ч” being the predecessor of “ё” is 0.962389. The letter combination “чё” has significant synergetic effect as the probability of appearance of letter “ч” equals 0.05327, whereas for letter “ё” it is 0.0004175. Therefore, for all letter combinations “ачё”, “бчё”,…, “ячё” the combined conditional probability estimate $p_9(\text{ч}/\text{ё})$, $p_9(\text{ч}/\text{ёё})$,…, $p_9(\text{ч}/\text{яё})$ is calculated by deviation 0.962389 from 0.05327 (because letter “ё” provides the probability almost equal to 1 of the fact that there will be letter combination with letter “ч” in it). However, in reality in the text, letter combinations “ачё”, “бчё”,…, “ячё” (except “вчё”) did not appear (probability equals 0). The same case is for words “эт[о,а,у]”. In these words, letter “ы” appears with probability 0.90176.

Synergetic effect and restriction of choices in letter combinations for the stated words gives the difference in standard deviation which equals 0.00302. This exceeds common difference in deviations
(0.00248, see table 7, columns “Method 2” and “NFIM”). Without words “всё” and “это” the values of deviations are completely different (table 9).

The verification showed that in other languages there are no such frequently used words that form total high probability of appearance of certain letters.

Table 9

| Base               | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|--------------------|------------------------------|-----------------|-----------------|--------------------|----------|----------|----------|----------|------|-----------------------|
| All words          | 1                            | 0.09457         | 0.08879         | 0.09018            | 0.08228  | **0.07842** | 0.08170  | 0.08182  | 0.08090 | -3.05                 |
| Without words “всё” and “это” | 1 | 0.095 | 0.08781 | 0.08957 | 0.08204 | 0.08112 | 0.07844 | 0.08079 | 0.08021 | **0.0779** | 0.7 |

*Note: the best results are highlighted*

Experiment 3. Calculation of standard deviation of combined conditional probability estimate from statistical combined conditional probability of sequence of fragments of one part of texts using the approximation coefficients of the other texts.

**Evaluation criterion:** standard deviation (36).

As it was shown in experiment 1, there is a problem with using the methods which are based on approximation. Coefficients that give the biggest approximation of linear equation to the values of combined conditional probability in one text are not optimal for other texts. For example, coefficients of method 2 (see table 7) for one-letter fragments of the Russian texts, which provide result even better than NFIM, were not the best for other texts. There were the experiments conducted which showed the increase of standard deviation if substituting coefficients of one part of texts with coefficients from the other texts (table 10).

Taking into account the results provided in table 10, it is possible to state once again that method which is based on the model of non-force interaction is universal (is suitable for different texts without changes in coefficients), while methods based on approximation can work effectively only with those texts for which the formula is developed (for example, only this piece of writing or, probably, works of only one writer).

**Comment to experiments 2 and 3.** It has already been said that with set initial data (unconditional and certain conditional probabilities) it is impossible to calculate combined conditional probability. However, it can be evaluated. As it is seen from tables 7-10, the biggest approximation to combined conditional probability is provided by non-force interaction method. Moreover, in methods that are based on approximation the calculation of coefficients was made from the position of minimum deviation from combined conditional probability (formulae 28, 30, 32 and 34). Nevertheless, non-force interaction method is still the best.

Undoubtedly, any method, including the stated one, does not allow to calculate combined conditional probability precisely. The deviation of non-force interaction method is explained by the structure of natural language where a word is more than just the sum of letters, but also contents, because letters do not have contents, and a word has.
Table 10

Standard deviation of estimates from probability of text fragment sequence by non-force interaction method and approximation methods with different coefficients

| Base          | Base from which coefficients are taken | L | Approximation methods | Non-Force Interaction Method |
|---------------|---------------------------------------|---|-----------------------|-----------------------------|
|               |                                       |   | Method 1   | Method 2 | Method 3 | Method 4 |                         |
| “Russian”     | “Russian”                             | 1 | 0.08170 | **0.07842** | 0.08182 | 0.08117 | 0.08090 |                         |
|               |                                       | 2 | 0.04107 | 0.04028  | 0.04106 | 0.04073 | **0.03951** |                         |
| “German”      | “German”                              | 1 | 0.08226 | **0.07937** | 0.08243 | 0.08181 | 0.08090 |                         |
|               |                                       | 2 | 0.04109 | 0.04039  | 0.04109 | 0.04078 | **0.03951** |                         |
| “English”     | “English”                             | 1 | 0.08714 | 0.08690  | 0.08559 | 0.08596 | **0.08142** |                         |
|               |                                       | 2 | 0.05110 | 0.05019  | 0.05102 | 0.05058 | **0.04839** |                         |
| “Ukrainian”   | “Ukrainian”                           | 1 | 0.06694 | 0.06486  | 0.06544 | 0.06455 | **0.06204** |                         |
|               |                                       | 2 | 0.04637 | 0.04561  | 0.04634 | 0.04589 | **0.04491** |                         |
| “Russian”     | “Russian”                             | 1 | 0.06723 | 0.06500  | 0.06595 | 0.06489 | **0.06204** |                         |
|               |                                       | 2 | 0.04642 | 0.04562  | 0.04640 | 0.04596 | **0.04491** |                         |
| “English”     | “English”                             | 1 | 0.07845 | 0.07769  | 0.07768 | 0.07787 | **0.07466** |                         |
|               |                                       | 2 | 0.04127 | 0.04049  | 0.04124 | 0.04092 | **0.03948** |                         |
| “Ukrainian”   | “Ukrainian”                           | 1 | 0.07854 | 0.07831  | 0.07787 | 0.07825 | **0.07466** |                         |
|               |                                       | 2 | 0.04134 | 0.04060  | 0.04131 | 0.04120 | **0.03948** |                         |

Note: the best results are highlighted

This is a synergetic effect of natural language. Earlier (in comments to table 9) it was explained how words “всё” and “это” influence the statistics. Indeed, if one letter from the text is taken, let it be “c”, it speaks about nothing. There are a lot of possible words with this letter. For two letters “cm” the probability of appearance of any word containing letters “cm” is higher than probability of appearance of a word with letter “т” or “c”. Let us add one more letter “cma”. It is even higher. If we add letter “n”, for this combination of letters (a word “cman” – “condition” in Ukrainian), the probability is almost 1. Therefore, for more “informative” letter combinations the probability tends to 1, and for non-informative it tends to 0. This creates a deviation when using any other method. However, the fact that the non-force interaction method gives the smallest deviation from statistical combined conditional probability confirms that in the mechanisms of speech production (human intellectual apparatus) the processes of interaction can be based on the algorithms which result from the information-probabilistic interpretation of mechanical movement.

It is no wonder, probably, that in the basis of different processes of interaction (on micro- and macro-levels of matter existence) there are same laws. It would be strange if this did not happen. Thus, it can be used in many situations, including the development of artificial intelligence systems.

One of the tasks connected to such systems is the task of predicting. To create a reliable forecast in stochastic subject fields, it is not really crucial which is the probability of occurrence of all events, the most important is which event has the highest probability. There were conducted experimental researches that allow to determine the most probable text fragment by the highest estimate of combined conditional probability using different methods. Let us consider the results.
**Experiment 4. Forecasting of text fragment sequence**

**Evaluation criterion:** the percentage of correctly predicted text fragments (38)

The forecast is based on the choice of the biggest combined conditional probability estimate (38). As a result of processing of the texts results stated in table 11 were obtained.

As it can be seen in table 11, the advantage of the non-force interaction method is rather substantial. Among the methods which are based on linear approximation the best is the one that uses the difference between the smallest conditional probability and unconditional probability (33). Moreover, it is more effective than the approximation methods that are oriented at conditional probabilities only. However, it is the deviation of conditional probability from unconditional one that interprets relative velocity of objects and is in the basis of the formula (19). This, once again, confirms that in a human brain the value of non-force (information) action is represented by the deviation of conditional probability of certain reaction (in experiments it was language) from unconditional one. Returning to NFIM, it gives the best result even without aiming at the selection of the biggest conditional probability (which is dictated by the expressions 29, 33).

### Table 11

**Forecasting of text fragment sequence by different methods**

| Base         | L  | By unconditional probability ($\mu_1$) | By 1st fragment ($\mu_2$) | By 2nd fragment ($\mu_3$) | By mean probability ($\mu_4$) | Method 1 ($\mu_5$) | Method 2 ($\mu_6$) | Method 3 ($\mu_7$) | Method 4 ($\mu_8$) | NFIM ($\mu_9$) | Advantage of NFIM (%) (39) |
|--------------|----|--------------------------------------|--------------------------|--------------------------|-------------------------------|--------------------|--------------------|--------------------|--------------------|--------------|-----------------------------|
| “Russian”    | 1  | 11,54                                | 19,37                    | 19,17                    | 22,92                         | 22,88              | 25,61              | 25,22              | 26,19              | 27,98        | 6,40                        |
| “German”     | 2  | 1,77                                 | 12,58                    | 12,88                    | 20,06                         | 20,04              | 26,45              | 20,15              | 25,08              | 28,02        | 5,60                        |
| “Ukrainian”  | 1  | 16,05                                | 26,64                    | 26,64                    | 26,64                         | 34,27              | 33,25              | 35,80              | 35,22              | 36,76        | 4,37                        |
| “English”    | 2  | 3,63                                 | 15,83                    | 13,89                    | 22,90                         | 22,89              | 26,28              | 23,43              | 26,62              | 30,25        | 12,00                       |

Note: the best results are highlighted.

**Experiment 5. Ranking of estimates of combined conditional probability of text fragment sequence.**

**Criterion of evaluation:** deviation in ranks (40)

Within experiments, there was made ranking of probability estimates with comparison with the ranks of the probabilities themselves. The deviation of ranks of combined conditional probability estimates received by different methods from the rank of statistical combined conditional probability was evaluated. The deviation in ranks by formula (40) for different methods is provided in table 12.

The received distribution of ranks states even bigger advantage of non-force interaction method in comparison with others provided in this paper. With the help of this method, it is possible to determined more exactly which of the variations of forecast can be counted upon and which cannot.

**Experiment 6. The graph of deviation of combined conditional probability estimate received by the non-force interaction method from statistical combined conditional probability of text fragment sequence.**

The deviations of values of combined conditional probability received by the non-force interaction method from statistical combined conditional probability of text fragment sequence in “English” base which were received in the process of experiments are provided in table 13. According to these data, the graph was created (fig.3)
Table 12

Standard deviation of ranks of combined conditional probability estimates and the rank of conditional probability of text fragment sequence

| Base       | \( L \) | By unconditional probability | By 1\(^{st} \) fragment | By 2\(^{nd} \) fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | Non-force interaction method | Advantage of NFIM (%) (41) |
|------------|--------|-------------------------------|--------------------------|--------------------------|---------------------|----------|----------|----------|----------|-------------------------------|----------------------------|
| “Russian”  | 1      | 37.74                         | 25.71                    | 24.19                    | 19.62               | 19.65    | 16.38    | 17.28    | 19.18    | 11.48                         | 42.62                      |
|            | 2      | 21.88                         | 14.63                    | 14.59                    | 11.80               | 11.81    | 11.27    | 10.89    | 11.17    | 8.98                          | 21.30                      |
| “German”   |        |                               |                          |                          |                     |          |          |          |          |                               |                            |
|            | 1      | 24.10                         | 18.11                    | 13.11                    | 12.47               | 12.99    | 11.61    | 10.85    | 10.70    | 7.60                          | 40.85                      |
|            | 2      | 20.02                         | 14.17                    | 12.11                    | 11.18               | 11.20    | 10.15    | 10.11    | 9.78     | 7.52                          | 30.03                      |
| “Ukrainian”|        |                               |                          |                          |                     |          |          |          |          |                               |                            |
|            | 1      | 41.62                         | 27.53                    | 25.18                    | 23.81               | 23.91    | 18.28    | 19.76    | 17.09    | 10.07                         | 69.78                      |
|            | 2      | 3.27                          | 2.07                     | 2.15                     | 1.84                | 1.84     | 1.74     | 1.73     | 1.62     | 1.50                          | 8.03                       |
| “English”  |        |                               |                          |                          |                     |          |          |          |          |                               |                            |
|            | 1      | 30.99                         | 19.32                    | 18.52                    | 14.78               | 14.87    | 13.40    | 12.43    | 13.02    | 8.74                          | 42.21                      |
|            | 2      | 63.06                         | 42.61                    | 41.05                    | 32.79               | 32.79    | 31.63    | 29.96    | 31.07    | 24.62                         | 21.69                      |

Note: the best results are highlighted.

As it can be seen from the graph, the received combined conditional probability estimates differ slightly from combined conditional probabilities themselves and form the peak of distribution in point “0” (deviation is absent).

To confirm the received results, there were conducted additional experiments which did not characterise the accuracy of determination of text structure, but rather show the versatility of methods developed in the non-force interaction theory.

Fig.3. Distribution of deviation of combined conditional probability estimate received by non-force interaction method from its statistical value in “English” base (one-letter fragments)

11. ADDITIONAL EXPERIMENTAL RESEARCHES

As it can be seen from the tables stated in section 10, the best result is provided by the method based on the non-force interaction theory, even though, from the point of view of probabilistic approach, the approximation-based methods should be better, as coefficients for equations are chosen in such a way that they should give the smallest deviation square, thus the biggest approximation to the probabilities themselves.
Table 13

The deviation of combined conditional probability estimate received by non-force interaction method (“English” base) from statistical combined conditional probabilities

| Deviation | Quantity | \(<0.60\) | \(0.59\) | \(0.57\) | \(0.56\) | \(0.55\) | \(0.54\) | \(0.53\) | \(0.52\) | \(0.51\) | \(0.5\) | \(0.49\) | \(0.48\) | \(0.47\) | \(0.46\) | \(0.45\) | \(0.44\) | \(0.43\) | \(0.42\) | \(0.41\) | \(0.4\) | \(0.39\) | \(0.38\) | \(0.37\) | \(0.36\) | \(0.35\) | \(0.34\) | \(0.33\) | \(0.32\) | \(0.31\) | \(0.3\) | \(0.29\) | \(0.28\) | \(0.27\) | \(0.26\) | \(0.25\) | \(0.24\) | \(0.23\) | \(0.22\) | \(0.21\) | \(0.2\) | \(0.19\) | \(0.18\) | \(0.17\) | \(0.16\) | \(0.15\) | \(0.14\) | \(0.13\) | \(0.12\) | \(0.11\) | \(0.1\) | \(0.09\) | \(0.08\) | \(0.07\) | \(0.06\) | \(0.05\) | \(0.04\) | \(0.03\) | \(0.02\) | \(0.01\) | \(-0.1\) | \(-0.2\) | \(-0.3\) | \(-0.4\) | \(-0.5\) | \(-0.6\) |
|-----------|----------|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 32        |          | -0.21     | 29      | 0.18    | 26      |
| 1         | 1        | -0.2      | 20      | 0.19    | 26      |
| 2         | 2        | -0.19     | 18      | 0.2     | 19      |
| 3         | 3        | -0.18     | 24      | 0.21    | 15      |
| 4         | 4        | -0.17     | 30      | 0.22    | 13      |
| 5         | 5        | -0.16     | 29      | 0.23    | 12      |
| 1         | 6        | -0.15     | 35      | 0.24    | 11      |
| 2         | 7        | -0.14     | 38      | 0.25    | 17      |
| 1         | 8        | -0.13     | 43      | 0.26    | 14      |
| 5         | 9        | -0.12     | 43      | 0.27    | 7       |
| 3         | 10       | -0.11     | 46      | 0.28    | 8       |
| 5         | 11       | -0.1      | 52      | 0.29    | 5       |
| 3         | 12       | -0.09     | 75      | 0.3     | 9       |
| 6         | 13       | -0.08     | 77      | 0.31    | 5       |
| 1         | 14       | -0.07     | 98      | 0.32    | 4       |
| 1         | 15       | -0.06     | 151     | 0.33    | 3       |
| 2         | 16       | -0.05     | 141     | 0.34    | 2       |
| 5         | 17       | -0.04     | 177     | 0.35    | 9       |
| 6         | 18       | -0.03     | 250     | 0.36    | 2       |
| 6         | 19       | -0.02     | 403     | 0.37    | 4       |
| 8         | 20       | -0.01     | 762     | 0.38    | 3       |
| 6         | 21       | 0         | 6471    | 0.39    | 4       |
| 12        | 22       | 0.01      | 2015    | 0.4     | 5       |
| 9         | 23       | 0.02      | 724     | 0.41    | 2       |
| 6         | 24       | 0.03      | 427     | 0.42    | 5       |
| 10        | 25       | 0.04      | 298     | 0.43    | 3       |
| 6         | 26       | 0.05      | 212     | 0.45    | 1       |
| 14        | 27       | 0.06      | 135     | 0.46    | 2       |
| 8         | 28       | 0.07      | 99      | 0.47    | 1       |
| 13        | 29       | 0.08      | 105     | 0.48    | 2       |
| 12        | 30       | 0.09      | 89      | 0.49    | 1       |
| 10        | 31       | 0.1       | 78      | 0.5     | 1       |
| 5         | 32       | 0.11      | 52      | 0.51    | 1       |
| 13        | 33       | 0.12      | 36      | 0.54    | 1       |
| 15        | 34       | 0.13      | 38      | 0.55    | 1       |
| 16        | 35       | 0.14      | 39      | 0.56    | 1       |
| 19        | 36       | 0.15      | 27      | 0.59    | 1       |
| 12        | 37       | 0.16      | 39      | 0.6      | 1       |
| 21        | 38       | 0.17      | 25      | ≥0.60   | 5       |

Thus, a question arises. What if non-force interaction method does not operate the information part of the text production, but rather uses only the deviations of probabilities as a characteristics of fragment sequence appearance in a text? In this way, the information-probabilistic interpretation of mechanical
movement is not reflected in a human brain during text production? In order to verify or deny this, the following experiment was conducted.

**Experiment 7. Research of random texts with even distribution of the letters of alphabet.**

Evaluation criterion: all stated in section 7.

There were texts generated, the sizes of which were equal to those used in experiments, but they had equal distribution of letter sequence. Of course, when increasing the size of text indefinitely there would be received the following value of probabilities:

\[ p(a_i/a_{i-1}a_{i+1}) \approx p(a_i/a_{i-1}) \approx p(a_i/a_{i+1}) \approx p(a_i). \]

Therefore, all methods used in this paper would give the same result!

When the size of the text is limited, it is highly likely that there will be deviations of values of conditional probabilities from unconditional ones. In this case, the results of predicting of text fragment sequence and standard deviation of probability estimates made by different methods will be different.

In total, for each language, there were generated 40 random texts equal by the size to the texts of bases used. Standard deviations of combined conditional probability estimates from combined conditional probabilities of text fragment sequence of a random text are shown in table 14. Mean values of the forecast of text fragments made by different methods are shown in table 15. The deviations in ranks are in table 16. In contrast to the experiments with real texts, here only one-letter fragments were used, as even distribution is the same for both one- and two-letter fragments. Moreover, for one-letter pieces, each fragment appears more often. Therefore, the statistics is better.

As it can be seen from tables 14-16, method based on the non-force interaction theory is inferior by almost all points comparing to the methods which use the approximation of probabilities. It means that it is the content part of the text, the processes of interaction that form what the method “processes”, and not just probabilities. However, for “random” text, it is not better than the methods of approximation, as it should be according to classical mathematical principles.

In table 14, it can be seen that the more the size of the text is, the smaller is standard deviation. This complies with the idea that for “indefinite” sizes of random texts all probability estimates will be equal to probabilities themselves.

**Standard deviation of estimates from fragment sequence probabilities for the texts with even distribution of the letters of alphabet ( \( \sigma \cdot 10^2 \))**

| Text by base size | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) (37) |
|-------------------|-----------------------------|-----------------|----------------|--------------------|----------|---------|---------|---------|------|---------------------------|
| “Russian”         | 0.323559                    | 0.318828        | 0.318831       | 0.316438           | 0.314176 | 0.314174 | 0.314028 | 0.314026 | 0.314028 | -0.000695                 |
| “German”          | 0.461893                    | 0.454350        | 0.454352       | 0.450529           | 0.446929 | 0.446920 | 0.446682 | 0.446675 | 0.446677 | -0.000373                 |
| “Ukrainian”       | 0.686833                    | 0.676246        | 0.676257       | 0.670897           | 0.665845 | 0.665828 | 0.665501 | 0.665487 | 0.665485 | 0.000275                  |
| “English”         | 0.195578                    | 0.192050        | 0.192052       | 0.190263           | 0.188596 | 0.188591 | 0.188458 | 0.188453 | 0.188459 | -0.003413                 |

*Note: highlighted are the results which are better than those received by the non-force interaction method.*
Table 15

| Text by base size | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|------------------|-------------------------------|-----------------|-----------------|---------------------|---------|---------|---------|---------|------|----------------------|
| “Russian”        | 78999.1                       | 81436.3         | 81426.3         | 82665.6             | 82664.8 | 82659.4 | 82691.9 | 82691.1 | 82688.9 | -0.003659            |
| “German”         | 42545.5                       | 44295.3         | 44271.9         | 45212.1             | 45213.0 | 45228.9 | 45236.5 | 45235.5 | -0.002155 |                   |
| “Ukrainian”      | 20153.7                       | 21463.4         | 21477.5         | 22175.2             | 22176.6 | 22170.3 | 22172.4 | 22177.1 | -0.030888 |                   |
| “English”        | 183095.9                      | 185953.9        | 185933.2        | 187219.2             | 187214.9 | 187241.0 | 187277.4 | 187278.7 | 0.000674  |                   |

Note: highlighted are the results which are better than those received by the non-force interaction method.

Table 16

| Text by example of base | % correct prediction of text fragment sequence | Advantage of NFIM (%) |
|-------------------------|-----------------------------------------------|-----------------------|
|                         | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM |
| “Russian”               | 164,760                          | 139,896          | 139,819         | 130,470             | 130,485 | 130,215 | 130,206 | 130,210 | 130,210 | -0.00769       |
| “German”                | 134,129                          | 112,559          | 112,505         | 104,600             | 104,623 | 104,378 | 104,364 | 104,373 | 104,373 | -0.01375       |
| “Ukrainian”             | 146,245                          | 121,950          | 121,923         | 114,341             | 114,372 | 114,365 | 114,098 | 114,106 | 114,106 | -0.01675       |
| “English”               | 104,389                          | 88,326           | 88,238          | 81,159              | 81,169  | 81,158  | 80,918  | 80,913  | 80,923  | -0.03079       |

Note: highlighted are the results which are better than those received by the non-force interaction method.

The non-force interaction method is the best only for small sizes of texts (“Ukrainian” base) (see table 14). However, even in this case, the advantage is minimum (0.000275%). Such exception only confirms the rule that the non-force interaction method works best with the objects that include the idea (meaning). This, in its turn, once more proves the important role of the non-force (informational) interactions when producing a text. Moreover, it also proves that processes of text production in a human brain correspond to the non-force interaction model which was received from information-probabilistic interpretation of mechanical movement and is the basis of the non-force interaction theory.

The NFIM was worse than other methods at ranking probability estimates (see table 16). Comparing with table 12, it is possible to reiterate that the non-force interaction method is effective only for “sensible” (intelligent) rather than random texts. This characterizes the level of influence of mechanics of natural text creating in a human brain (including forming of words) which is recognized by the non-force interaction method. Therefore, this means it is the contextual part of language that it operates with. Thus, this part of language functions according to the laws which are depicted in the non-force interaction method, that is movement and direct (contact) interaction in the information-probabilistic interpretation. Hence, what if it is not an interpretation but rather a reality?

Furthermore, what can happen if all texts are combined into one? There was an experiment with the text conducted which includes all four bases: Russian, German, Ukrainian and English.
Experiment 8. The research of a combined text
Criterion of evaluation: all stated in section 7.
There were the rates of effectiveness developed for the combined text: standard deviation from combined conditional probability (table 17) and quantity of correctly predicted text fragments (table 18). Apart from that, the deviation of probability estimate rank from combined conditional probability rank was evaluated for the combined text (table 19).

**Table 17**

| L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.09561 | 0.08543 | 0.08991 | 0.08024 | 0.07874 | 0.07693 | 0.07800 | 0.07765 | 0.07508 | 2.46 |
| 2 | 0.04628 | 0.04535 | 0.04527 | 0.04423 | 0.04404 | 0.04324 | 0.04401 | 0.04365 | 0.04230 | 2.22 |

Note: the best results are highlighted.

**Table 18**

| L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Fragment total | Advantage of NFIM (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 894574 | 1617312 | 1595614 | 2001922 | 1992145 | 2136515 | 2083939 | 2165393 | 2260531 | 7456824 | 4.21 |
| 2 | 201116 | 957000 | 946025 | 1479064 | 1476830 | 1826359 | 1498931 | 1794563 | 1991002 | 7456816 | 8.27 |

Note: the best results are highlighted.

**Table 19**

| L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35,10 | 23,62 | 21,33 | 18,65 | 18,79 | 15,80 | 15,93 | 15,79 | 9,79 | 61.27 |
| 2 | 34,80 | 23,54 | 22,64 | 18,36 | 18,36 | 17,60 | 16,80 | 17,53 | 13,72 | 22.47 |

Note: the best results are highlighted.

What can be seen from tables 17-19? All rates of the NFIM are much higher than for other methods! Even if compared with linear approximation. By the way, the author tried using linear approximation, that is deviation square of conditional probability from an unconditional one. Of course, it does not eliminate the possibility of that someone will discover such an equation which will give bigger approximation to combined conditional probability than the NFIM for some text. As in “Russian” base, where there are one-letter fragments (see table 7). However, whether this equation will fit other texts it unknown. According to the results stated in table 10, it is highly unlikely.

As it can be seen from the provided tables (see tables 11 and 18), the approximation method which operates with deviations of conditional probability from an unconditional one (33) is not bad for forecasting, which Method 4. Therefore, the question arises. What if this difference is replaced with the
non-force action value received in NFIT (which is also based on the difference between unconditional and conditional probability), how will the forecast change?

**Experiment 9. Comparison of the effectiveness of the methods which are based on the deviation of conditional probability from an unconditional one and the value of non-force influence.**

**Criterion of evaluation:** the percentage of correctly predicted text fragments (38).

Since method 4 is quite effective for predicting text fragment sequence, it is proposed to replace the difference between conditional and unconditional probability with the value of non-force influence (in the basis of which there is also a deviation of conditional probability from an unconditional one) (19), and the deviation of estimate from probability is replaced by achievement of the maximum results in predicting of the texts:

\[ p_{10}(a_i/a_{i-1}a_{i+1}) = \delta_1 \cdot p_i^{max} + \delta_2 \cdot (p_i^{min} - p(a_i)) + \delta_3. \]

Let us apply formula (9) in formula (19) and “improve” formula (33), replacing the difference in probabilities with non-force influence value

\[ p_{10}(a_i/a_{i-1}a_{i+1}) = \delta_1 \cdot p_i^{max} + \delta_2 \cdot (d_i^{min} \cdot \sqrt{d(a_i)^2 + 1} - d(a_i) \cdot \sqrt{(d_i^{min})^2 + 1}) + \delta_3, \]

under the condition that

\[ \mu_8(\delta_1, \delta_2) \cdot \sum_{a_{i-1}a_{i+1}} n(a_i) \to \max; \]

\[ \mu_{10}(\delta_1, \delta_2) \cdot \sum_{a_{i-1}a_{i+1}} n(a_i) \to \max, \]

where \( \mu_8(\delta_1, \delta_2) \) is the percentage of correct predictions of text fragment sequence by method 4; \( \mu_{10}(\delta_1, \delta_2) \) is the percentage of correct predictions of text fragment sequence by method 5; \( p_{10}(a_i/a_{i-1}a_{i+1}) \) is the estimate of conditional probability of sequence of text fragment \( a_i \) by linear approximation of non-force influence of the fragment with the smallest conditional probability: if the previous text fragment is \( a_{i-1} \); if the following text fragment is \( a_{i+1} \) (Method 5); \( \delta_1, \delta_2 \) are approximation coefficients; \( d_i^{min} \) is the amount of information that triggers the reaction, which is calculated by formula (11) with argument \( p_i^{min} \); \( d(a_i) \) is the amount of information that triggers the reaction, which is calculated by formula (11) with argument \( p(a_i) \).

The results of predicting made by such combined method (method 5) are provided in table 20. The result once again confirms higher descriptiveness of non-force interaction method regarding calculation of combined conditional probability, for example, the actions of artificial intelligence systems, and its higher “usefulness” in solving problems of predicting.

| L | Quantity of correctly determined text fragments |
|---|-----------------------------------------------|
|   | Method 4 | Method 5 |
| 1 | 2242440 | 2259673 |
| 2 | 1985547 | 2000457 |

**Note:** the best results are highlighted

**Experiment 10. Using instead of unconditional probability the conditional one, which excludes the cases when previous and subsequent fragments are the current ones.**

**Criterion of evaluation:** all stated in section 7.

To calculate the values of influence, it would be necessary to use conditional probability which would not include those cases when previous fragment was \( a_{i-1} \) and the following was \( a_{i+1} \). Then the
non-force value itself would exactly reflect the appearance of these fragments. However, the research has shown

\[
p(a_i) \approx p(a_i/\bar{a}_{i-1}); \\
p(a_i) \approx p(a_i/\bar{a}_{i+1}),
\]

where \(p(a_i/\bar{a}_{i-1})\) is statistical conditional probability of the sequence of fragment \(a_i\) when the previous fragment was not \(a_{i-1}\); \(p(a_i/\bar{a}_{i+1})\) is statistical conditional probability of the sequence of fragment \(a_i\) when the following fragment is not \(a_{i+1}\).

This was verified in the selected texts. The results are provided in table 21.

Nevertheless, in order to avoid doubts regarding the objectivity of the received results, there were conducted experiments using provided conditional probabilities \(p(a_i/\bar{a}_{i-1})\), \(p(a_i/\bar{a}_{i+1})\) instead of unconditional \(p(a_i)\). The results are stated in tables 22-24.

As it can be seen in tables 22-24, the non-force interaction method remains the best of all others.

**Experiment 11. Consideration of the combinations of fragments in which both conditional probabilities of appearance of a text fragment are not equal to zero \((p(a_i/\bar{a}_{i-1}) > 0, p(a_i/\bar{a}_{i+1}) > 0)\).**

Criterion of evaluation: all stated in section 7.

### Table 21

| Base     | | Deviation of probability | | % deviation |
|----------|---|--------------------------|---|----------|
|          | | Mean | Maximum | Mean | Maximum |
| “Russian”| 1 | 0.000746 | 0.003368 | 2.460 | 11.115 |
|          | 2 | 0.000002 | 0.000022 | 0.147 | 2.083 |
| “German” | 1 | 0.000887 | 0.004520 | 2.662 | 13.560 |
|          | 2 | 0.000003 | 0.000073 | 0.195 | 5.257 |
| “Ukrainian” | 1 | 0.000830 | 0.002823 | 2.655 | 9.034 |
|          | 2 | 0.000002 | 0.000016 | 0.145 | 1.500 |
| “English” | 1 | 0.001045 | 0.003581 | 2.717 | 9.310 |
|          | 2 | 0.000003 | 0.000064 | 0.199 | 3.923 |

### Table 22

| Base     | | By unconditional probability | | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|----------|---|-----------------------------|---|----------------|------------------|-------------------|---------|---------|---------|---------|------|----------------------|
| “Russian”| 1 | 0.09545 | 0.08880 | 0.09019 | 0.08228 | 0.08170 | **0.07843** | 0.08176 | 0.08120 | 0.08107 | -3.26 |
|          | 2 | 0.04314 | 0.04236 | 0.04227 | 0.04121 | 0.04107 | 0.04028 | 0.04106 | 0.04074 | **0.03952** | 1.94 |
| “German” | 1 | 0.11050 | 0.09320 | 0.10388 | 0.08973 | 0.08715 | 0.08690 | 0.08565 | 0.08617 | **0.08233** | 4.03 |
|          | 2 | 0.05481 | 0.05296 | 0.05323 | 0.05148 | 0.05110 | 0.05019 | 0.05102 | 0.05058 | **0.04838** | 3.73 |
| “Ukrainian” | 1 | 0.08394 | 0.07339 | 0.07588 | 0.06849 | 0.06694 | 0.06486 | 0.06543 | 0.06469 | **0.06223** | 3.95 |
|          | 2 | 0.04804 | 0.04731 | 0.04715 | 0.04662 | 0.04637 | 0.04561 | 0.04634 | 0.04589 | **0.04490** | 1.58 |
| “English” | 1 | 0.10177 | 0.08646 | 0.09298 | 0.08130 | 0.07845 | 0.07769 | 0.07775 | 0.07808 | **0.07504** | 3.53 |
|          | 2 | 0.04394 | 0.04292 | 0.04265 | 0.04149 | 0.04127 | 0.04049 | 0.04124 | 0.04093 | **0.03948** | 2.55 |

*Note: the best results are highlighted*
Predicting of text fragment sequence by different methods using conditional probabilities

\[ p(a_t/a_{t-1}), p(a_t/a_{t+1}) \] instead of unconditional probabilities

| Base    | L | By unconditional probability (\(\mu_1\)) | By 1st fragment (\(\mu_2\)) | By 2nd fragment (\(\mu_3\)) | By mean probability (\(\mu_4\)) | Method 1 (\(\mu_5\)) | Method 2 (\(\mu_6\)) | Method 3 (\(\mu_7\)) | Method 4 (\(\mu_8\)) | NFIM (\(\mu_9\)) | Advantage of NFIM (%) |
|---------|---|----------------------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------|----------------------|----------------------|----------------------|------------------|----------------------|
| “Russian” | 1 | 11.54 | 19.37 | 19.17 | 22.92 | 22.88 | 25.61 | 25.36 | 26.17 | 27.66 | 5.39 |
|         | 2 | 1.77 | 12.58 | 12.88 | 20.06 | 20.04 | 26.45 | 20.16 | 25.04 | 27.84 | 4.99 |
| “German” | 1 | 16.05 | 26.97 | 26.64 | 34.27 | 33.25 | 35.80 | 35.28 | 36.65 | 37.39 | 1.98 |
|         | 2 | 3.31 | 15.83 | 13.89 | 22.90 | 22.89 | 26.28 | 23.45 | 24.59 | 30.00 | 11.37 |
| “Ukrainian” | 1 | 6.62 | 17.30 | 17.72 | 21.77 | 21.42 | 24.28 | 23.79 | 25.15 | 25.60 | 1.76 |
|         | 2 | 0.74 | 9.12 | 9.63 | 15.38 | 15.38 | 19.93 | 15.45 | 19.90 | 22.40 | 11.03 |
| “English” | 1 | 11.79 | 22.35 | 21.93 | 28.11 | 27.86 | 29.21 | 28.64 | 29.26 | 29.86 | 2.01 |
|         | 2 | 3.19 | 12.61 | 12.36 | 19.44 | 19.33 | 23.35 | 19.89 | 23.01 | 25.43 | 8.18 |

Note: the best results are highlighted

Table 23

Standard deviation of ranks of combined conditional probability estimates from ranks of statistical combined conditional probabilities of text fragment sequence using conditional probabilities \(p(a_t/a_{t-1}), p(a_t/a_{t+1})\)

| Base    | L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | Non-force interaction method | Advantage of NFIM (%) |
|---------|---|-------------------------------|-----------------|-----------------|---------------------|----------|----------|----------|----------|-------------------------------|----------------------|
| “Russian” | 1 | 40.32 | 25.71 | 24.19 | 19.62 | 19.65 | 16.38 | 17.44 | 19.52 | 11.43 | 43.33 |
|         | 2 | 22.72 | 14.63 | 14.59 | 11.80 | 11.81 | 11.27 | 10.90 | 11.17 | 9.05  | 20.38 |
| “German” | 1 | 26.12 | 18.11 | 13.11 | 12.47 | 12.99 | 11.61 | 10.90 | 10.94 | 7.64  | 42.61 |
|         | 2 | 21.07 | 14.17 | 12.11 | 11.18 | 11.20 | 10.15 | 10.12 | 9.84  | 7.61  | 29.22 |
| “Ukrainian” | 1 | 44.41 | 27.53 | 25.18 | 23.81 | 23.91 | 18.28 | 19.63 | 17.30 | 10.14 | 70.61 |
|         | 2 | 3.37 | 2.07 | 2.15 | 1.84 | 1.84 | 1.74 | 1.73 | 1.62 | 1.50 | 7.78 |
| “English” | 1 | 33.74 | 19.32 | 18.52 | 14.78 | 14.87 | 13.40 | 12.61 | 13.28 | 8.91 | 41.42 |
|         | 2 | 65.33 | 42.61 | 41.05 | 32.79 | 32.79 | 31.63 | 29.99 | 31.10 | 24.75 | 21.15 |

Note: the best results are highlighted

One more experiment was connected to the decision accepted in the methodology of experimental research. It is to consider combinations of fragments for which at least one probability is not equal to zero (p.6 of section 5): \(n(a_{i-1}, a_i) > 0\) or \(n(a_i, a_{i+1}) > 0\). Since, under the condition that \(n(a_{i-1}, a_i) = 0\) or \(n(a_i, a_{i+1}) = 0\), combined conditional probability estimate calculated by the non-force interaction method will also be equal to zero, this does not create additional advantage to it comparing with others.

However, from the point of view of the development of artificial intelligence systems this approach is correct. As it is not improbable that when increasing the statistics, zero probability will become not equal to zero. Hence, these cases should be considered, too.

Results are provided in tables 25-27.

As it can be seen from tables 25-27, the change of methodology does not violate previous result, when the non-force interaction method is the most effective (according to the criteria stated in section 7) of all others.
Table 25

Standard deviation of combined conditional probability estimates from statistical combined conditional probability of text fragment sequence under the condition: 
\[ p(a_i/a_{i-1}) > 0 \text{ and } p(a_i/a_{i+1}) > 0 \]

| Base   | By unconditional probability \((\mu_1)\) | By 1st fragment \((\mu_2)\) | By 2nd fragment \((\mu_3)\) | By mean probability \((\mu_4)\) | Method 1 \((\mu_5)\) | Method 2 \((\mu_6)\) | Method 3 \((\mu_7)\) | Method 4 \((\mu_8)\) | NFIM \((\mu_9)\) | Advantage of NFIM (%)
|--------|-----------------------------------------|-----------------------------|-----------------------------|-------------------------------|------------------|------------------|------------------|------------------|----------------|------------------|
| “Russian” | 1 | 0.10384 | 0.09712 | 0.09882 | 0.09044 | 0.08896 | 0.08974 | 0.08943 | 37 | -3.24 |
| “German” | 2 | 0.08976 | 0.08699 | 0.08522 | 0.08404 | 0.08312 | 0.08395 | 0.08301 | 0.08237 | 0.78 |
| “Ukrainian” | 1 | 0.12585 | 0.10803 | 0.11927 | 0.10399 | 0.10074 | 0.10063 | 0.09900 | 0.09507 | 3.98 |
| “English” | 2 | 0.12943 | 0.12273 | 0.12361 | 0.12064 | 0.11757 | 0.11694 | 0.11610 | 0.11469 | 1.23 |

Note: the best results are highlighted.

Table 26

Predicting of text fragment sequence by different methods under the condition: 
\[ p(a_i/a_{i-1}) > 0 \text{ and } p(a_i/a_{i+1}) > 0 \]

| Base   | By unconditional probability \((\mu_1)\) | By 1st fragment \((\mu_2)\) | By 2nd fragment \((\mu_3)\) | By mean probability \((\mu_4)\) | NFIM \((\mu_9)\) | Advantage of NFIM (%)
|--------|-----------------------------------------|-----------------------------|-----------------------------|-------------------------------|----------------|------------------|
| “Russian” | 1 | 11.56 | 19.42 | 19.17 | 22.95 | 22.98 | 25.50 | 25.27 | 26.39 | 27.98 | 5.68 |
| “German” | 2 | 2.66 | 15.51 | 15.49 | 21.72 | 21.69 | 26.46 | 21.85 | 27.11 | 28.02 | 3.25 |
| “Ukrainian” | 1 | 16.19 | 27.02 | 26.85 | 34.32 | 33.32 | 35.70 | 35.98 | 36.79 | 38.44 | 4.29 |
| “English” | 2 | 5.42 | 19.08 | 17.73 | 24.86 | 24.86 | 26.49 | 25.52 | 28.40 | 30.25 | 6.12 |

Note: the best results are highlighted.

For artificial intelligence systems, it is highly important to have consistency of received results under different conditions. Usually, to verify any methods, samplings are divided into training and control ones. Probabilities received in training samplings and coefficients of approximation equations are applied to the control sampling. Within experimental research, the results of which are provided in this article, there also was such an experiment.

Experiment 12. Research of the text divided into training and control samplings.

Criterion of evaluation: all stated in section 7.

To have objective results, especially those concerning approximation methods, all the texts were divided randomly into two samplings, each having 50% the size of the text: training and control. By the training sampling, approximation coefficients and unconditional probabilities of text fragment appearance were calculated. In the control sampling, according to the criteria described in section 7, the effectiveness of provided methods was verified. The results are stated in tables 28-30.
Table 27

Standard deviation of ranks of combined conditional probability estimates from the ranks of statistical combined conditional probabilities of text fragment sequence under the condition: $p(a_i/a_{i-1}) > 0$ and $p(a_i/a_{i+1}) > 0$

| Base    | L   | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|---------|-----|------------------------------|-----------------|-----------------|---------------------|----------|----------|----------|----------|------|----------------------|
| “Russian” | 1   | 37.74                        | 25.71           | 24.19           | 19.62               | 19.66    | 16.51    | 17.26    | 19.75    |      | 11.48                | 43.77 |
|          | 2   | 21.88                        | 14.63           | 14.59           | 11.80               | 11.81    | 11.22    | 10.90    | 11.48    |      | 8.98                 | 21.34 |
| “German” | 1   | 24.10                        | 18.11           | 13.11           | 12.47               | 12.89    | 11.84    | 10.72    | 10.86    |      | 7.60                 | 41.09 |
|          | 2   | 20.02                        | 14.17           | 12.11           | 11.18               | 11.20    | 10.48    | 10.10    | 9.84     |      | 7.52                 | 30.90 |
| “Ukrainian” | 1   | 41.62                        | 27.53           | 25.18           | 23.81               | 23.91    | 18.62    | 19.76    | 17.05    |      | 10.07                | 69.32 |
|          | 2   | 3.27                         | 2.07            | 2.15            | 1.84                | 1.84     | 1.75     | 1.73     | 1.63     |      | 1.50                 | 8.71  |
| “English” | 1   | 30.99                        | 19.32           | 18.52           | 14.78               | 14.88    | 13.48    | 12.42    | 13.27    |      | 8.74                 | 42.06 |
|          | 2   | 63.06                        | 42.61           | 41.05           | 32.79               | 32.79    | 31.43    | 29.96    | 31.91    |      | 24.62                | 21.66 |

Note: the best results are highlighted.

As it is seen from tables 28-30, there has nothing changed. The NFIM is the best and its advantage over the other methods in some cases even increased (see tables 7, 11, 12).

Table 28

Standard deviation of combined conditional probability estimates from statistical combined conditional probability of text fragment sequence in control text sampling

| Base    | L   | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|---------|-----|------------------------------|-----------------|-----------------|---------------------|----------|----------|----------|----------|------|----------------------|
| “Russian” | 1   | 0.09627                      | 0.09058         | 0.09147         | 0.08388             | 0.08189  | **0.07887** | 0.08181  | 0.08116  | 0.08217 | -4.01                |
|          | 2   | 0.04718                      | 0.04629         | 0.04623         | 0.04518             | 0.04478  | 0.04387  | 0.04477  | 0.04435  |      | **0.04324**            | 1.45  |
| “German” | 1   | 0.11047                      | 0.09504         | 0.10505         | 0.09139             | 0.09011  | 0.08998  | 0.08863  | 0.08908  |      | **0.08278**            | 7.06  |
|          | 2   | 0.05956                      | 0.05748         | 0.05777         | 0.05601             | 0.05537  | 0.05436  | 0.05526  | 0.05473  |      | **0.05256**            | 3.42  |
| “Ukrainian” | 1   | 0.08554                      | 0.07608         | 0.07845         | 0.07129             | 0.06995  | 0.06790  | 0.06857  | 0.06772  |      | **0.06470**            | 4.66  |
|          | 2   | 0.05486                      | 0.05398         | 0.05385         | 0.05325             | 0.05256  | 0.05155  | 0.05252  | 0.05187  |      | **0.05116**            | 0.78  |
| “English” | 1   | 0.10079                      | 0.08688         | 0.09318         | 0.08161             | 0.07838  | 0.07742  | 0.07758  | 0.07769  |      | **0.07487**            | 3.41  |
|          | 2   | 0.04686                      | 0.04571         | 0.04552         | 0.04437             | 0.04407  | 0.04327  | 0.04403  | 0.04368  |      | **0.04222**            | 2.47  |

Note: the best results are highlighted.

12. SUMMARY

When verifying theorems automatically, their validity can be proven by going through all constant cases. The first person to highlight this was Jacques Herbrand [32]. In the logic of predicates of the first order in far-away 1930, he proposed the procedure of verification based on the theorem which states: a range of disjuncts $S$ is impossible when and only when there is finite impossible range of fundamental examples (i.e. constant cases) of disjuncts with $S$. 
Table 29

Predicting of fragment sequence of control text sampling made by different methods

| Base            | % of correct prediction of text fragment sequence | Advantage of NFIM (%) |
|-----------------|-----------------------------------------------|-----------------------|
|                 | By unconditional probability (μ₁)             | By 1st fragment (μ₂)  | By 2nd fragment (μ₃) | By mean probability (μ₄) | Method 1 (μ₅) | Method 2 (μ₆) | Method 3 (μ₇) | Method 4 (μ₈) | NFIM (μ₉) | Advantage of NFIM (%) |
| Russian         | 11.57  | 19.37  | 19.19  | 23.11  | 23.20  | 25.54  | 25.37  | 26.24  | 28.05  | 43.15  |
|                 | 1.79   | 12.61  | 12.94  | 20.16  | 20.16  | 26.59  | 20.24  | 25.55  | 28.44  | 1.45   |
| German          | 16.00  | 26.92  | 26.64  | 34.28  | 33.56  | 35.73  | 35.24  | 36.72  | 38.44  | 7.06   |
|                 | 3.64   | 15.87  | 13.98  | 22.87  | 22.85  | 26.30  | 23.40  | 26.83  | 30.53  | 3.42   |
| Ukrainian       | 9.24   | 17.39  | 17.72  | 21.66  | 21.65  | 24.22  | 23.75  | 25.47  | 25.98  | 4.66   |
|                 | 1.38   | 9.22   | 9.82   | 15.82  | 15.81  | 20.91  | 15.91  | 21.25  | 23.67  | 0.78   |
| English         | 11.79  | 22.34  | 21.90  | 28.13  | 27.66  | 29.22  | 28.64  | 29.25  | 30.41  | 3.41   |
|                 | 3.20   | 12.62  | 12.36  | 19.40  | 19.38  | 23.39  | 19.91  | 23.10  | 25.70  | 2.47   |

Note: the best results are highlighted.

Table 30

Standard deviation of ranks of combined conditional probabilities estimates from ranks of statistical combined conditional probabilities of fragment sequence from control text sampling

| Base            | L | By unconditional probability | By 1st fragment | By 2nd fragment | By mean probability | Method 1 | Method 2 | Method 3 | Method 4 | NFIM | Advantage of NFIM (%) |
|-----------------|---|-----------------------------|-----------------|-----------------|---------------------|---------|---------|---------|---------|------|-----------------------|
| Russian         | 1 | 35.62                       | 24.32           | 22.82           | 18.64               | 18.65   | 15.56   | 16.06   | 17.26   | 10.87| 43.15                |
|                 | 2 | 9.97                        | 6.59            | 6.54            | 5.37                | 5.37    | 5.09    | 4.98    | 4.94    | 4.13 | 19.61                |
| German          | 1 | 21.45                       | 16.25           | 12.07           | 11.40               | 11.86   | 10.58   | 10.08   | 9.88    | 6.97 | 41.75                |
|                 | 2 | 11.78                       | 8.25            | 6.97            | 6.61                | 6.62    | 6.03    | 6.00    | 5.66    | 4.55 | 24.40                |
| Ukrainian       | 1 | 35.60                       | 23.27           | 21.60           | 20.50               | 20.58   | 15.66   | 16.74   | 14.11   | 8.65 | 63.12                |
|                 | 2 | 1.22                        | 0.72            | 0.75            | 0.66                | 0.66    | 0.61    | 0.63    | 0.57    | 0.54 | 5.56                 |
| English         | 1 | 29.85                       | 18.37           | 17.77           | 14.17               | 14.28   | 12.78   | 11.71   | 12.22   | 8.33 | 40.58                |
|                 | 2 | 34.04                       | 22.67           | 22.16           | 17.55               | 17.56   | 16.92   | 16.13   | 16.46   | 13.40| 20.37                |

Note: the best results are highlighted.

The proof of the theorem is called the answer to the question whether some formula B logically follows out of the stated range of formulae $f₁, f₂ \ldots fₙ$:

$$f₁, f₂ \ldots fₙ \rightarrow B$$

is the verification of general validity of the formula.

It is much easier to prove the unprovability of the formula:

$$f₁, f₂ \ldots fₙ \rightarrow \neg B$$

— refutation procedure.

As for the question that is being considered in this article, it means that it is important to find such method of determination of combined conditional probability by unconditional and certain conditional ones which gives a better result than that offered in the non-force interaction theory. Moreover, it should be true for any texts.
The author did not manage to do this, despite doing his best. There is the last point, though. It seems that if from one text there are taken fragments \( p^{\text{text}1}(a_i/a_{i-1}) \) and \( p^{\text{text}1}(a_i/a_{i+1}) \), and the equivalent values of them are found in the other text

\[
p^{\text{text}2}(a_i/a_{i-1}) = p^{\text{text}1}(a_i/a_{i-1});
\]
\[
p^{\text{text}2}(a_i/a_{i+1}) = p^{\text{text}1}(a_i/a_{i+1}).
\]

then the value \( p^{\text{text}1}(a_i/a_{i-1}a_{i+1}) \) will be closer to \( p^{\text{text}2}(a_i/a_{i-1}a_{i+1}) \) than those received by listed methods. For example, if:

\[
p^{\text{text}1}(a_i/a_{i-1}) = p^{\text{text}2}(a_i/a_{i-1}) = 0.7;
\]
\[
p^{\text{text}1}(a_i/a_{i+1}) = p^{\text{text}2}(a_i/a_{i+1}) = 0.3;
\]
\[
p^{\text{text}1}(a_i/a_{i-1}a_{i+1}) = 0.8,
\]

then

\[ p^{\text{text}2}(a_i/a_{i-1}a_{i+1}) \approx 0.8. \]

Otherwise, if the value of combined conditional probability is different for the same values of certain conditional probabilities, the question arises. Is it at all possible to find the method which orients itself at probabilities and will provide a better result than the non-force interaction method?

There was an experiment conducted. In “English” base, the input conditional probabilities are determined. In “Russian” base, the conditional probabilities equal to them are found. Certainly, finding all the probabilities in “English” base correspondent to each conditional probability of text fragments in “Russian” base failed (the deviation within 0,0005 was allowed). There was found \( K=15307 \) one-letter fragments where probabilities match.

By these fragments using least square method there was calculated the deviation dispersion of probability \( p^{\text{English}}(a_i/a_{i-1}a_{i+1}) \) from probability \( p^{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \), and probability \( p^{9}_{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \) from probability \( p^{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \).

Here is the answer:

\[
\frac{\sum_{i=1}^{K}(p^{\text{English}}(a_i/a_{i-1}a_{i+1}) - p^{\text{Russian}}(a_i/a_{i-1}a_{i+1}))^2}{K} \approx 0.0031873;
\]
\[
\frac{\sum_{i=1}^{K}(p^{9}_{\text{Russian}}(a_i/a_{i-1}a_{i+1}) - p^{\text{Russian}}(a_i/a_{i-1}a_{i+1}))^2}{K} \approx 0.0017463,
\]

under the condition that

\[
|p^{\text{English}}(a_i/a_{i-1}) - p^{\text{Russian}}(a_i/a_{i-1})| < 0.0005;
\]
\[
|p^{\text{English}}(a_i/a_{i+1}) - p^{\text{Russian}}(a_i/a_{i+1})| < 0.0005,
\]

where \( K \) is the quantity of matches in the values of probabilities of “English” and “Russian” bases; \( p^{9}_{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \) is estimate of combined conditional probability of sequence of text fragment \( a_i \) by the non-force interaction method in “Russian base”; \( p^{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \) is combined conditional probability of sequence of text fragment \( a_{i-1} \) in “Russian” base; \( p^{9}_{\text{Russian}}(a_i/a_{i-1}a_{i+1}) \) is combined conditional probability of sequence of text fragment \( a_{i-1} \) in “English” base; \( p^{\text{Russian}}(a_i/a_{i-1}) \) is conditional probability of sequence of text fragment \( a_{i-1} \) in “Russian” base if the previous fragment is \( a_i \); \( p^{\text{Russian}}(a_i/a_{i+1}) \) is conditional probability of sequence of text fragment \( a_{i+1} \) in “Russian” base if the following fragment is \( a_{i+1} \).

Deviation dispersion of the probability calculated by the non-force interaction method is almost two times smaller than the dispersion of the probability deviation taken from the other text.
Therefore, the main conclusion of the experiments is the following: the method based on the non-force interaction theory is better when analysing natural language texts as it does not just operate probabilities, but rather reflects information interactions in a human brain while producing speech (letter combinations, words, sentences). Moreover, these interactions are described with the same formulae that are used in the description of mechanical movement and direct (contact) interaction of material objects if they are given information-probabilistic interpretation. In the author’s opinion, this states that there is the correspondence of the processes of information interaction in a human brain when producing natural language texts (the second signal system) to the processes of interaction at the microlevel of the Nature, which speaks about the general validity of the received non-force interaction formulae.

13. DISCUSSION

Is the information the basis of our Nature? Is it the foundation of all interactions? The results received make it very high that the probability of the fact that information also determines the processes of interaction on a physical level (interactions of different physical nature). Moreover, information processes in a human brain correspond to the non-force interaction model received from information-probabilistic interpretation of the laws of physics.

This direction is relevant and promising, open to work with for many scientists of different countries. Of course, the author is the advocate of the development in this direction. Furthermore, like nobody else, he is interested in that other scientists tried to refute this statement through other experiments. Then, if they fail to do so, this will be the confirmation of the non-force interaction theory (here is one more reference to Herbrand [32]).

14. PRACTICAL IMPLEMENTATION

If the consistent patterns in estimating combined conditional probability by the non-force interaction method are preserved in different subject fields, this creates a possibility to develop artificial intelligence systems, in which by the deviation of conditional probabilities from unconditional ones the value of the non-force influence of various factors will be calculated. Then, the total of these influences will determine the most probable reaction of the system. This will allow to create simple, cheap and … effective artificial intelligence systems in which accumulated statistic information will be in the basis of reflexes (development of the most probable reactions to external influences). Allow us to illustrate.

Let us assume that in the process of previous training the adequate reactions of the system to external influences were determined. The training process was in consistent exposure on the system showing adequate reactions:

Training sampling 1: $W_{k_1} \rightarrow R_{i_1}$;
Training sampling 2: $W_{k_2} \rightarrow R_{i_2}$;
……………………………………
Training sampling $j$: $W_{k_j} \rightarrow R_{i_j}$;
……………………………………
Training sampling $N$: $W_{k_N} \rightarrow R_{i_N}$;

where $W_{k_j} \subseteq W$ is a subrange of the factors of influence on the system at $j$-th step of training; $R_{i_j} \in R$ is an adequate reaction of the system at $j$-th step of training; $W$ is the range of factors of influence; $R$ is the range of reactions.

Let us assume that at the moment of time $t$, the system is exposed to the influences that are included in the subrange $w_s \in W_0$. $\forall R_i \in R, \forall w_s \in W_0: p(R_i/w_s)$.

Of course, if in the system memory, the reaction to all this subrange of influences is determined, $\exists R_q \in R: p(R_q/W_0) = 1$, ...
the task of decision making is trivial. The decision is reaction $R_q$. However, usually there are so many influences that it is impossible to accumulate statistics for all these combinations. In this case, the non-force interaction method can become useful. As it is possible to calculate the value of the influence on the reaction by deviation of $p(R_i/w_0)$ from $p(R_i)$. Then, the reaction with the highest combined conditional probability estimate $p_0(R_q/W_0)$ can be chosen and implemented (see section 6).

As it was shown in the experiments and practice, the combined conditional probability estimate of the reaction calculated by the non-force interaction method allows to choose correct reactions in different subject fields in 99% of cases [4,6,30,33]. At the moment, on the basis of the non-force interaction method the systems of reactive artificial intelligence machines that produce adequate reactions to the influences of the multitude of factors have been and are being developed. The author and his students have created the systems of: predicting the results of sport games, evaluation of investment proposals in development, access the databases using natural language, automatic abstracting of texts, automatic message forwarding, voice control of TV and phone, etc. [4]. The main advantage of these systems is not even the fact that they are more effective than others, but rather in the fact that the expenses on their development are minimum.

How do they work and why are they called the systems of a reactive type? The work started from the creation of the system of access to the database of the construction of Southern Ukrainian Nuclear Power Station using natural language [30]. It was developed the automated system which included almost all data necessary for construction: drawings (specifications), budget estimates, plans, scopes of conducted works, material and technical resources. Most of the workers had low level of computer skills (it was in 80s of the 20th century). Therefore, they were offered a system КЕТ (“компилятор естественно-языковых текстов” in Russian, “natural language compiler” in English) which had single window where a user wrote their request in natural language. For example, “What scope of works was made last month in reactor department by subdivision PROM-1”. There were standard reactions entered in the system. They were fulfilled by database management system КВАНТ-M:

- tasks: planned scopes of works, planned cost of works, performance of works, need for resources;
- construction objects: reactor department, generator hall, etc. (more than 100 objects);
- performers (people responsible) (more than 100 organisations and subdivisions);
- and other.

During the training, the teacher entered a random sentence and chose corresponding reaction. In essence, the reflex to a request was developed. The reflex was created in the following way:

1. Input text was divided into fragments (from 2 to 10 symbols).
2. For each fragment, statistical probability of choice of each reaction (conditional probability) was calculated.
3. For each reaction, its statistical probability of choice (unconditional probability) was calculated.
4. The difference between conditional and unconditional probabilities for each reaction of each fragment was treated as a value of non-force (information) influence on this reaction by this fragment.

The use of the system showed its high reliability when processing users’ requests. The probability of correct reaction for non-programming professionals (engineers, skilled workers, foremen) exceeded 95%. The most importantly, the system did not need to perform morphological, syntax, semantic analysis of the text as it is done by similar systems. The non-force interaction method is a really simple and reliable method of creation of the systems of natural language!

One more similar system was depicted in the publication [6]. This is the system of TV voice control. The principles, method and algorithm are the same as described in the system of access to databases. However, at the input it is not the text that is entered, but phonemes of a language. The probability of correct reaction in this system is close to 0.99.

The system of predicting the results of sport matches [1] works in a slightly different way. As an influenced object, there is a result of a match (win, draw, loss). As influencing objects there are various
factors: the result of a previous match, what were the previous results of the matches between the same competitors, on whose field the game is, how many goals are scored and missed in previous matches. Factors like weather, referee, availability of a stronger team, etc. can be added. In this case, the unconditional probability of each result (win, draw, loss) of each team is chosen from the statistics, as well as conditional probabilities of these results, but only if the selected influence factors exist. The non-force influence, which is calculated as it is described in subsection 2.3, characterises many factors that in total give a different value of result probability. Taking into account many factors gives probable result of a match. The statistics of predicting leading championships of European countries and matches of representative teams has been accumulated for 10 years. The probability of correct predicting of results in different championships varies from 0.55 to 0.65 (English championship is the most difficult to predict), and it reaches 0.7 for the matches of representative teams.

In the system of evaluation of investment proposals in development, the values of various parameters of projects (location, destination, cost, etc.) were calculated. This system is unique because in the process of experimental research it gave 100% match of parameter values to the ones given by experts [33].

15. CONCLUSIONS

The confidence of the author in the validity of the non-force interaction theory, its versatility, is based on computer experiments and practical implementation of the systems created with the use of the results receive in the non-force interaction theory [4, 6, 30, 33]. The theory was received from computer experiments in the basis of which it was the assignment of information content to objects (see fig.1) and modelling of their mechanical movement and interaction during collision (the law of conservation of momentum) [4]. The information-probabilistic interpretation of mechanical movement was the result of these experiments. The next step of work on any theory is its experimental verification and practical implementation.

This work is dedicated to experimental verification of the general validity of the formulae of dealing with the information content of interacting objects, which were received from the information-probabilistic interpretation of mechanical movement. Specifically, its correspondence to the interaction processes that happen and happened in a human brain when producing natural language texts. All computer experiments, the results of which are provided in this article definitely show that the non-force interaction theory formulae allow to describe statistical consistent patterns in the texts of different languages more exactly than other methods selected for the experiments. In its turn, this allows to state that there is a high probability of the interactions at both micro- and macro-levels of the Nature are informational (non-force) ones and are describes with the same formulae.

However, it is also possible that it is not the information-probabilistic interpretation of mechanical movement that is primary, and it is not the one to be taken as the foundation of the research of natural language texts. It is possible that the existence of the systems in which the information lies in the basis of their life-sustaining activity, and their development, training and self-development, and their reflexes were the basis of the creation of “informational laws” of mechanical movement. Moreover, it is these laws that we research in the computer simulation that we call the Universe [1, 34-38]…

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**Figure 1**

Information-probabilistic model of mechanical movement. $i^+ -$ the size of the area to determine the movement in the direction $Z$; $i^- -$ the size of the area to determine the movement in direction opposite to $Z$; $p^+ -$ probability of a shift in direction $Z$; $p^- -$ probability of a shift in direction opposite to $Z$.

| “Russian” Base 2165328 letters | “English” Base 3784551 letters | “German” Base 1062279 letters | “Ukrainian” Base 531926 letters |
|---------------------------------|---------------------------------|-------------------------------|-------------------------------|
| сейчасприбравиланана птуспооковая ныничечемен няедваочень интересные человекакстативиконтм ортетамонроводесемон моранесичрезрогановоди аизлучшихфамилийфра нининэтоодиниз хороших эмигрантовизнастающих ипоматабатмовровиз аетэтоотглебукностьм быватьтгосударемвыз насте | fromfairestcreatureswedesirein creasethattherebybeautyisrosem ightneverdiebutasteripershou dbytimedeceaschistenderheim ghtbearismemorybuthoucon tractedtothineownbrighteyesfe edsthylightsflamewithselfsubs tancialfuelmakingafaminewher eabundanceliesthyselfthyfootot hysweetselfioocuethouthatart nowtheworldsfreshornamentan donlyheraldtothedaudyinspringw ithinthineownbudburiesthycon tentandtenderchurlmaksstwastei nniggardingpitytheworldmorelseth thisgluttonbetoeatheworldsdu ebythegraveandthee | gleicheineraltenhalbv erklungensagekom mtersteliebundfreund schaftmitheraufdresc hmerzwirdneueswied erholtdecklagedesleb enslabyrinthischiren lauf | огожиротинакогоозап итаёхтойроизкажеихт отеєзнаєдеилийиноч єчизтємомугаючив бистрімдунайокняна повачиможе другогооод ругююкохаєйчорнообр івуужезабува |

**Figure 2**

The fragments of texts prepared for experiments
Figure 3

Distribution of deviation of combined conditional probability estimate received by nonforce interaction method from its statistical value in “English” base (one-letter fragments)