

Research on Information Literacy Education Based on Gaussian distribution and Neural Network Model

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Abstract: At present, most of the research on College Students' information literacy is based on the research model by induction and summary, which has many problems. This paper studies from both individual learning and group environment, then forms a vertical gradient structure, and establishes a multi-layer iteration model from the neural network learning process of human, and constructs a three-dimensional research model to study information literacy education of college students from macro and micro scales. It also proposes a method combining Delphi Method with Gaussian distribution for the characteristics study of iteration layer, and gives a quantifiable research scheme, which has practical value.

1. Introduction

Information literacy is the basic ability that talents in modern information society need to possess[1] and is the basic requirement of quality education. In a society where information resources become the main factor of production, college students must have well information literacy, including tactful information awareness, the ability to quickly and accurately acquire and evaluate information, the capacity to analyze, process and use information, and the correct information security awareness and information ethics in order to adapt to the rapid development of information society.

The concept of information literacy was first put forward by Paul Zurkowski, who is the president of the American Information Industry Association (AIIA): "after training, a person can use information in his work, has mastered the use of information tools and familiar with the main sources of information and can solve practical problems. That is to say, he has information literacy." [2]. The American Library Association (ALA) has more specific criteria for information literacy: the ability of timely awareness of information needs, and experienced in searching, critically evaluating and effectively steering information [3].

In China, the research on information literacy is relatively late. Ma Haiqun defined information literacy as "an individual possessed the qualities in the information society, including the information of wisdom (involving information knowledge and skills), morality, consciousness, awareness, concept, potential, psychology, etc." in Information Literacy Education in 1997. Sang Xinmin proposed the goal system of cultivating the students information literacy in 2000:

- (1) the ability to acquire information quickly and effectively;
- (2) the ability to proficiently evaluate information;
- (3) the ability to absorb, store and extract information;
- (4) the ability to express information in the form of multimedia and creatively use information;
- (5) the ability to integrate the above information into a group of independent and efficient learning and communication skills;
- (6) Learning, cultivating and improving citizens' moral, emotional, legal awareness and social responsibility in the information era [4].

Overall, the understanding of information literacy is essentially the same in China. Most people start from phenomena and summarize the general theory. This paper focuses on quantifying the Information literacy of group through the Gaussian distribution. At the same time, this paper studies the cognitive learning principle of individual neural network to accurately improve the effect of information literacy education from the microscopic point of view, puts forward a new research model and raises a practical quantitative analysis method.

2. The Relationship between Group Behavior and Individual Behavior

2.1 Gaussian distribution

The Gaussian distribution is a common continuous probability distribution function. It is very important in statistics. And, it is often used in natural and social sciences to represent an unknown random variable.

$$X \sim N(\mu, \sigma^2) \tag{1}$$

The probability density function is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \tag{2}$$

The universal mean or expectation of Gaussian distribution determines the location of distribution. The square or standard deviation of the variance determines the distribution range.

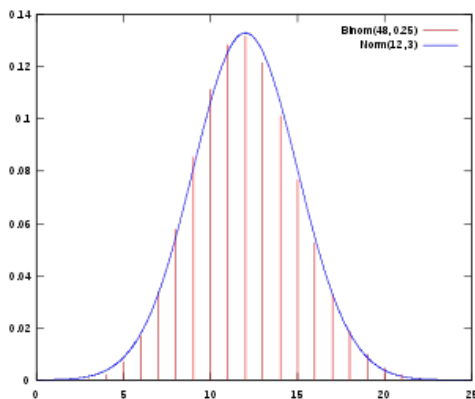


Fig.1 Gaussian distribution

Gaussian distribution has a very important property: after statistic the average of a large number of independent and random variables under specified conditions, their distribution tends to Gaussian distribution, which is the central limit theorem. The significance of the central limit theorem is that other probability distributions can be approximated by Gaussian distribution according to the conclusion of this theorem.

2.2 The group Information literacy obeys Gaussian distribution

The information literacy on university students is also a kind of group behavior ability. The object is that college students have a huge group base, and the random variable is the information literacy level of students. In theory, the information literacy level of college students obeys Gaussian distribution. According to the central limit theorem, the level of most students is steady in average, while a minority of students is at a higher or lower level[5].

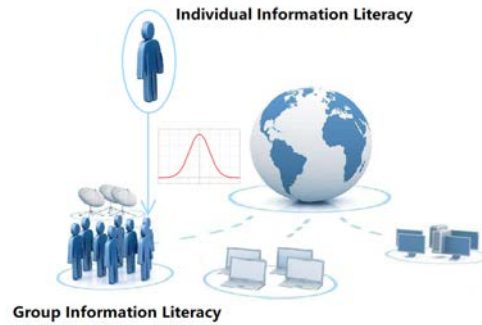


Fig.2 The relationship between individual and group information literacy

In order to verify this theory, we can adopt the method of questionnaire test. The key factors of College Students' information literacy are designed as test contents, and the students' information literacy level is measured by their test scores. According to the experience of many tests, most of the students' test scores obey the Gaussian distribution [6]. Wang Zaifeng and others put forward that the humanity of the group follows the Gaussian distribution, which also verifies the characteristics of the group behavior obeying the Gaussian distribution [7].

2.3 Gaussian Distribution and the education of Individual Information Literacy

The information literacy level of college students obeys Gaussian distribution. Information literacy education aims to improve the information literacy level of college students through acquired learning, which requires increasing the average μ in the Gaussian distribution. This average μ is the level of most people in the group. That is to say, we need to study the common characteristics of information literacy of most individuals. The common characteristic of individual information literacy is the typical characteristic of individual information literacy learning process. Previous studies did not analyze the impact of individual learning process and group behavior on information literacy education, but only summarized the laws from some phenomena unilaterally and did not grasp the nature of the problem. This paper will comprehensively improve the effect of information literacy education by studying the cognitive learning principles of individual and group neural networks. The typical features of different levels of neural network are extracted by Gaussian distribution analysis method, and a new set of information literacy research theory for college students is constructed.

Individual information literacy education mainly studies its education and learning process. In order to improve the information literacy of individuals, we must grasp the key indicators that affect them. Through a large number of questionnaires, the index data were obtained. Moreover, it can directly show the current level of students' information literacy through the study of Gaussian distribution. In this way, we can extract backward indicators and focus on improving them. It can also provide a platform and resources by the group environment, and design a reasonable learning path.

3. Cognitive Principle of Neural Network

There is a lot of research that suggests the human brain consists of about 1011 nerve cells and 1015 synapses in the field of brain neuroscience. These nerve cells and their synapses constitute a huge biological neural network. Each nerve cell connects and transmits information through synapses with other nerve cells. When the signal intensity received through the synapse beyond a certain threshold, the nerve cells will be activated. Then, activating signals are sent to the upper neurons through synapses. All human activities, which are related to consciousness and intelligence, are realized through the mutual activation and cooperation of nerve cells in specific regions[8].

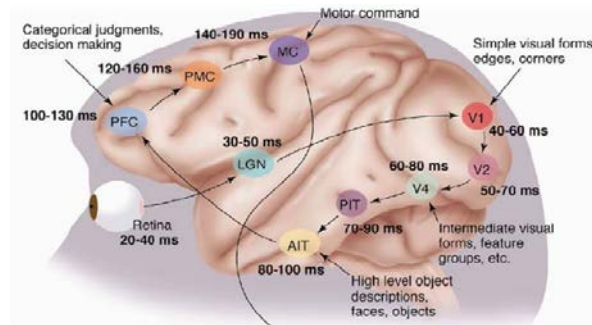


Fig.3 The structure of human brain

David Hubel and Torsten Wiesel discovered information processing in the visual system. The principles of human vision system are as follows: Start with the intake of the original signal (read pixels through pupils), then do the preliminary treatment (some cells in the cerebral cortex extract edges and directions), then abstract (the brain judges that the shape of the object in front of it is circular), and finally further abstract (the brain further determined that the object was a balloon). Here is an example about human brain for face recognition:

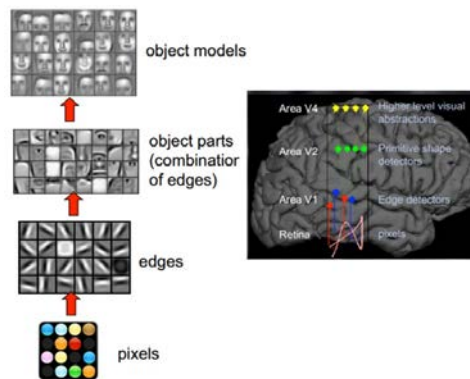


Fig.4 The information processing in human brain

Small pieces of graphics can be made up of basic edges. More structured, more complex and more conceptual graphics need to be represented by using higher level character, such as V2, V4. Therefore, V1 is at the pixel-level. V2 is at the pixel level for V1's basis. This is a hierarchical progressive relationship. The high-level expression is composed of the low-level combination. Professional point is the basis. Basis extracted from V1 is an edge. Then, the V2 is composed of the V1's basis. At this time, the basis obtained in V2 area is a higher level. That is, the base of each level is composed of a lower level. The upper layer is the result of the combination of the lower layer[9].

The information processing of human visual system is hierarchical. The edge characters are extracted from the low-level V1 region, then the shape or part of the target obtained from the V2 region, and then the whole target and the behavior of the target are analyzed at the higher level. In other words, high-level characters are combinations of low-level characters. From the lower level to the higher level, the feature representation becomes more and more abstract and is increasingly able to express semantics or intentions. Furthermore, the higher the level of abstraction, the fewer possible guesses there are. It is the better for the brain to classify[10].

4. Neural Network Model of Information Literacy Education

4.1 Design of Neural Network Education Model

The learning process of neural networks can be simply described as: starting from the intuitive impression of things, the iteration algorithm is constantly updated information, and finally the recognition of things is formed. The whole process is from simple to complex, from concrete to abstract.

The purpose of information literacy education is to improve the information literacy competency. The way to improve is continuously learning by instruction. The whole learning process is inseparable from the human neural network learning system. Countless individuals form a social group. This also enables social groups to have a more comprehensive learning ability. Therefore, social groups have more abstract neural network systems. The neural network model of information literacy education can be divided into groups and individuals. The group is mainly to construct information resources, platforms, environments and so on. The individual is mainly the process of learning and practicing information literacy.

The learning process of neural network is a process of digesting, absorbing and synthesizing information by starting learning with basic features and abstracting constantly. Thus, the neural network education model has two layers of structure: Basis Layer and Iterative Layer.

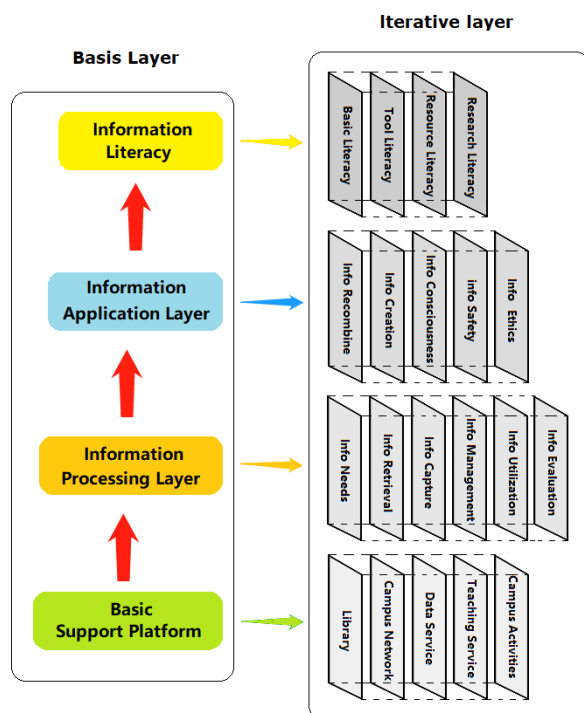


Fig.5 The information processing in human brain

4.2 The Group Neural Network Model

The group neural network model consists of Basis Layer and Iterative Layer, where Basis Layer provides Basic Support Platform, and mainly composed of Library, Campus Network, Data Service, Technology Service, Campus Action, etc.. Iterative Layer consists of Basic Support Platform, Informational Development Layer, Informational Application Layer, Informational Limited.

Basic Support Platform mainly provides the technology, platform, resources and environment needed for information literacy education, which is a necessary condition. On this basis, the first iteration of the college students' neural network is completed. The specific infrastructure is abstracted into Information Processing, including information collection, management, learning, evaluation and so on. After digesting and absorbing information and knowledge, the group neural network completes the second iteration. Then, subconscious cognition is formed by abstracting knowledge into concrete applications including the reorganization and creation of information. After that, the group neural network completes the third iteration. Finally, these subconscious perceptions are abstracted into information literacy.

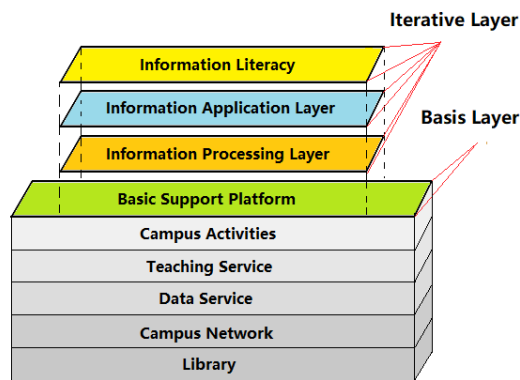


Fig.6 The Group Neural Network Model

4.3 The Individual Neural Network Model

The individual neural network model conducts a layered study of college students' information literacy education, which is the iterative layer in the group neural network model. Each layer is a new neural network model consisting of Basis Layer and Iterative Layer.

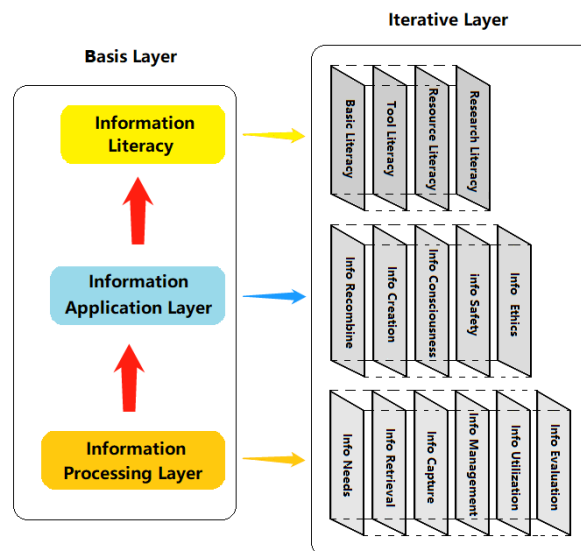


Fig.7 The Individual Neural Network Model

Information Processing Layer:

The first iteration of the Information Processing Layer produces info needs. These info needs are abstracted into a need through the characteristics of a specific task. We need to collect some information to meet our needs. How to get information? We tend to be used retrieval techniques. After we have this information, we need to sort and store it. Using this information, we can solve our needs, and we will also evaluate the quality of this demand satisfaction, which mainly depends on the quality of information.

For example: You want to drive to Suzhou, but you don't know how to get there? First you need to navigate. Secondly, you need to use mobile map. Then you have to tell the map where you want to go through the keywords. Finally, use mobile map to plan your route. You get route information, but you can't remember it. At this time, you can copy it or use the map navigation function to help you manage the path information. In the end, it takes you 30 seconds to complete the navigation requirements accurately. The information you get is precise and the access to information is smooth. You are satisfied with the navigation requirements and complete the evaluation of the information.

Information Application Layer:

Through the iteration of a large amount of information knowledge, not only the related information can be connected in series and parallel, but also the information can be reorganized. This process begins with simple patchwork information reorganization. Then the second iteration is carried out to complete the information creation process. This information is organized. Unlike information reorganization, information consciousness is generated iteratively in the process of information creation, which improves the efficiency of information creation. Complete the creation of information in consciousness, and begin to pay attention to the security of information in the process of information creation. From this, information ethics and law came into being.

Information Literacy:

Through information literacy education, individuals first have the basic literacy of information, such as listening, speaking, reading and writing. In the information activities use all kinds of technology, accumulated rich tools, which can be abstracted as Technical Literacy. Through these tools, individuals can easily access a large number of information resources. Resource Literacy comes into being in this process, mainly including network resource literacy and document resource literacy. The fourth iteration is more abstract and generates general research methods and exchange of research results.

4.4 Systemic Analysis Method

The human not only comes from nature, but also belongs to society. Information literacy education can not only analyze social groups, but also ignore the particularity of individuals. At the same time, we should not only analyze individual characteristics, but also ignore the impact of social groups on individuals. This requires the use of systematic analysis methods, from multiple levels to analyze.

The information literacy education neural network model is studied from the two aspects of individual learning and group environment and forms a vertical graded structure. At the same time, starting from the process of learning and cognition, the horizontal model of multi-level iteration will be established. Thus, a three-dimensional research model is constructed to study information literacy education of college students from macro and micro scales.

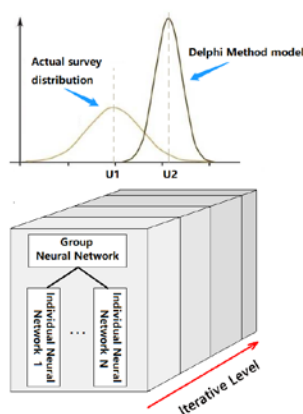


Fig.8 Systemic Analysis Method

The research of iteration layer is mainly focused on the typical characteristics through the use of Delphi Method. Through the expert questionnaire, the expert level of the characteristics of this layer is obtained. Then, through the questionnaire of students, we can get the true level of College Students' characteristics at this level. By comparing the Gaussian distribution of the two models, the importance coefficient of this feature is found and the quantitative analysis is carried out. In this paper, a simple formula for calculating the characteristic importance coefficient is given:

$$\text{Importance Coefficient} = (U2 - U1) / U2 \quad (3)$$

Where,

U2 is the average of Delphi Method Mode for a characteristic.

U1 is the average of a certain characteristic in college students' questionnaires.

5. Conclusion

The neural network model of information literacy education reveals its essence. At the same time, from the perspective of groups and individuals, the information literacy education of college students is analyzed to form a vertical graded structure. Furthermore, this model starts from the process of learning and cognition and establishes a horizontal model of multi-level iteration. Thus, a three-dimensional research model is constructed, which solves the problem of one-sided research in the past. In this paper, a method combining Delphi Method with Gaussian distribution is proposed for the study of iteration layer. And a quantifiable method is given which has strong practical value. In addition, this study gives the basic framework and research method of neural network education model. The follow-up research will continue to improve in this framework.

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