Application of artificial neural networks in the design of biomedical materials

Yu Chen¹

¹Material Science and Engineering of Sichuan University-Pittsburgh Institute, Chengdu, 610227, China

Abstract. Biomedical science is a scientific field that includes the intersection of multiple technologies, combining the theoretical methods of biology, medicine and engineering. Biomedical materials are now a branch of the body that studies materials that are adapted to the body's functioning to ensure normal human activity. Because of its closely related to human activities, it has become an important research field in our time. Therefore, the purpose of this paper is to explore the application of artificial intelligence in the design of biological science materials. Therefore, in the case of using high-quality materials, the material design is improved and optimized by using artificial neural networks under the basis of adverse rejection reactions to the properties of raw materials. The experimental results show that artificial neural network can be better connected and reaction, which is beneficial to improve sensitivity and use emergency measures to deal with it.

1 Introduction

With the improvement of social living standards, people's pursuit of health is more and more appropriate. However, due to the industrial society, accidents often occur, so the design of biomedical materials is very important, which will become one of the focus and core of our research in the future. In the future, we will help everyone to avoid mental disability caused by physical disability. We believe that we will succeed in the near future.

Through the investigation of relevant textbooks at home and abroad, it is found that the relatively perfect curriculum knowledge system of biomaterials generally includes the contents of materials science and biology [1]. From the perspective of materials science, the contents to be taught include the types, properties, chemical structures, physical properties, mechanical properties, degradation, processing technology and surface properties of biomaterials, so as to lay a good foundation for students in Materials Science [2-3]. From a biological point of view, the contents to be taught include the interaction between proteins, cells and biomaterials, as well as the acute inflammation, thrombosis, immune response, infection, tumor and calcification reactions induced by the introduction of biomaterial implants into the human body [4]. In view of this, the course system of biomaterials for undergraduates majoring in Biomedical Engineering in most universities consists of several courses, such as materials science, basic knowledge of biomaterials and artificial organs, introduction to biomedical engineering [5-6].

At present, most titanium alloy materials used in biomedical field are used to manufacture surgical implants

and plastic surgery equipment products, such as dental implants, artificial joints, vascular stents and other tissues [7]. As the load-bearing component of implanted human body, the implant material must have extremely high strength, excellent deflection and excellent elastic modulus to meet the requirements of matching with human body, so as to prevent the failure of implant material fracture on the body [8-9]. So, we use artificial neural network to construct a system to better match [10].

2 Artificial neural network algorithm

First, the input sample is weighted to the value of the first layer of the implied layer

$$S_{1j} = \sum_{i=1}^n W_{1ij} X_i - \theta_{1i}, \quad j=1,2, \dots, p \quad (1)$$

S_{1j} The value is available after the feature conversion function:

$$b_{1i} = 1/[1 + \exp(-\sum_{i=1}^n W_{1ij} X_i + \theta_{1j})] \quad (2)$$

The feature conversion function selected in this article is the number of sigmoid letters. The value of the first implied layer as input and the weight to the second implied layer is:

$$S_{2j} = \sum_{i=n+1}^{2n} W_{2ij} X_i (\theta_{1i} + \sum_{j=1}^p W'_{ij} - \theta_{2j}) \quad (3)$$

Then it is solved by the conversion function:

$$b_{2j} 1/[1 + \exp(-\sum_{i=1}^n W_{1ij} X_i + \sum_{j=1}^p W'_{ij} + \theta_{2j})] \quad (4).$$

The output of all implied layers is the result V_{it} :

$$L_t(\sum_{j=1}^p V_{jt} b_{2j}) \quad (5)$$

In the end we come up with a style (5), and that's the final result.

3 Model building

3.1 Establish an early warning system model

By analyzing the relationship between the parameters in the early warning system indicator system, two or two comparisons are made between the indicators at the same level, the model matrix is constructed, the characteristic value of the model matrix and its characteristic vector are calculated, and a test is carried out after the weight vector is derived.

Build two or two comparative indicators to judge matrix R:

$$\begin{aligned} R &= (r_{ij})_{m \times n} \\ i &= 1, 2, \dots, m \\ j &= 1, 2, \dots, n \end{aligned} \quad (6)$$

Make the things in R a planning process:

$$r''_{ij} = r_{ij} / \sum_{i=1}^n r_{ij} \quad (7)$$

$$r''_{ij} = \sum_{i=1}^m r_{ij} \quad (8)$$

$$W_{IJ} = r_{ij} / \sum_{i=1}^n r''_{ij} \quad (9)$$

$$\begin{aligned} A_w &= \lambda_{max} w \\ CI &= \frac{\lambda_{max} - n}{n - 1} \quad CR = \frac{CI}{RI} \end{aligned} \quad (10)$$

In the process of building the model above, RI is a random consistency indicator, if the $CR < 0.1$, then the consistency test passes, otherwise you will continue to correct the R of the indicator judgment, the above model fusion and the indicator evaluation weight, obtain the score of comprehensive evaluation, and determine the specific corresponding warning level formula is as follows:

$$E = F * W * V \quad (11)$$

4 Evaluation results

4.1 Application of data evaluation in sensor testing

Figure 1. Sensitivity distribution of emergency sensors

As can be seen from Figure 1, after many tests, it is concluded that the sensitivity of the emergency sensor is in the ascending state from 198 to 206, and then enters the decreasing state, so we can know from the data that the sensitivity of the emergency sensor The peak is reached at 206 hours, so in order to be more sensitive, we should maintain the frequency of the emergency sensor at about 206, but if there are other unknown factors interference, not detected is the current technical 2 problem, this article does not 20 consider.

In order to reduce the cost of emergency sensors, we have analyzed the typical methods at home and abroad, and proposed an emergency sensor based on non-

symmetric structure sensors to meet the comprehensive application requirements of emergency warning and corresponding treatment measures. We make up the sensitive components of the Quick Reporter with a single-component B-type sensor and two three-component C-type sensors. By replacing the symmetrical three-component Type B sensor, you can reduce the cost to one-third of the original cost. In addition, with high-precision 32-bit A/C converters and embedded systems as the core, an arm-based data acquisition device is designed that automatically extracts the arrival time of abnormal data fluctuations, obtains and publishes information, and reports quickly.

Table 1. The output value of the model and the two types of error analysis table

	Precise	Error-1	Error-2
Training set	96.5%	72%	28%
The test set	97.5	68%	32%

Table 2. An accurate analysis table of artificial neural networks

Sample.	Observed	Predicted	Correct rate
Training.	100	96	96%
	100	97	97%
	Total share	193	96.5%
Inspection.	100	98	98%
	100	97	97%
	Total share	195	97.5%

As can be seen from the data in Table 1 and Table 2, the accuracy model of artificial neural networks is predicted with an accuracy of 96.5percent. Among them, the training set and test set first type of error (normal data as%, error data) are 72%% and 68%, the second type of error (error data as normal data) is 28% and 32%. Respectively, the first type of error is larger than the second type of error, indicating that the model is relatively strict, with the correct data as error data is less).

For the biomedical materials empirically, the data is desensitized, real historical use records, the sample size of more than 30,000, from which we randomly selected 1000 to select experiments. The data set contains personal information about the use of the user, including detailed body data. After processing, we finally got the data as described above.

4.2 Production and application of biomedical materials

Over the past decade, a variety of biomass materials, including synthetic polymers, metals and biomes ceramics, have been developed. In tissue engineering and regenerative medicine, ceramics and biological materials from natural sources have been developed. It is widely used. Collagen and other natural biological materials have good bio-compatible biological function and biodegradability has been widely concerned in clinical applications. For example, collagen is widely used as a leather filler, dental barrier film and dressing. Although they are similar to the host's extracellular substrings, they still exist. There are many issues worth studying, and one of the most important issues in clinical applications is the immune response after implantation in the body, including allergic reactions caused by the source of its extraction. Therefore, it is a hot research topic to improve biostability through chemical modification.

4.3 Classification of materials

4.3.1 Biomedical metal materials

As the name implies, biomedical metal materials are an inert material used in biomedical metals or alloys. This material has the characteristics of high mechanical strength and anti-fatigue. It is widely used in hard tissues such as bones and joints, artificial organs and surgical aids, and soft tissues such as artificial heart valves. Currently, the main materials used clinically are pure titanium, vanadium, vanadium and vanadium, which are called "living metals". Alloys are mainly stainless steel, cobalt-based alloys and titanium-based alloys. However, metal materials also have many disadvantages. For example, erosion of the biophysiological environment will cause metal ions to spread in biological tissues, leading to poisoning and severe rejection, leading to implant failure.

4.3.2 Biomedical inorganic non-metallic

Biomedical inorganic non-metallic materials are also known as bio-ceramics. It consists mainly of inorganic non-metallic materials such as ceramics, glass and carbon. It can be divided into three categories: active biological inorganic non-metallic materials, inert biological inorganic non-metallic materials and functional active bio-metallic materials. It has stable chemical and antibacterial properties and has good affinity with biological tissue, thus reducing implant rejection. It has high strength and corrosion resistance. Now used in artificial bones, artificial joints, artificial tendons, artificial blood vessels and so on. However, the bending strength of the material is low, the brittleness is high and it is prone to fatigue.

4.3.3 Biomedical Organic Polymer Medicine

Medical polymer material is a fast-growing field, its application and dosing are unmatched. There are mainly natural products and synthetic products, can be divided into non-degradable and biodegradable. Non-degradable types do not require their absolute stability, but require that they and their degradation products do not have significant adverse effects on the human body. This material is mainly used for human tissue repair, artificial organs, membrane repair, adhesives, etc. The advantages of degradable types are also evident. It is biodegradable and the degradation product can be absorbed or excreted by the body through normal metabolism. It is mainly used for drug release, i.e. drug coating or external capsules, and also for non-permanent implants.

4.3.4 Biomedical Composites

Biosynthetic materials are made up of more than two kinds of materials. Single materials do not meet clinical needs well, so composite materials are born. Compared with monosomic materials, the performance of composite materials has been greatly improved, can have a variety of advantages, and has a single material does not have new properties. At present, it has been widely used in clinical. Mutual learning can effectively develop new biomedical composites.

4.4 The meaning and composition of artificial neural networks

Artificial Neural Network (ANN) is a nonlinear and complex network system consisting of a large number of processing units similar to biological neurons. Since ANN put forward, it has a strong robustness, fault tolerance, self-learning and self-organization, can be completely similar to any complex nonlinear relationship, is widely used in many fields of complex intelligent information processing research.

In artificial neural networks, neuroprocessing units can represent different objects, such as features, letters, concepts, or some meaningful abstract pattern. There are three types of processing units in the network: input units, output units, and hidden units. The input unit receives signals and data from the outside world, the output unit output system processes the results, and the hidden unit is located between the input and output units and cannot be observed from outside the system through an artificial neural network. The connection weight between neurons reflects the strength of the connection between the cells, and the information is represented and processed in the connection relationship of the network processing unit. Artificial neural network is a kind of non-programming, adaptive and brain-based information processing. Its essence is to obtain parallel and distributed information processing function through network transformation and dynamic behavior, and imitate the information processing function of human brain nervous system in different degrees and levels. It covers neuroscience, thinking science, artificial intelligence, computer science and other

interdisciplinary fields.

According to the different learning environment, the learning method of neural network can be divided into supervised learning and unsupervised learning. In supervised learning, the data of the training sample is added to the network input, and the corresponding expected output is compared with the network output to obtain the error signal, thus controlling the adjustment of the connection strength. After many trainings, it converges to a certain weight. When the sample condition changes, you can modify the weights to accommodate the new environment. Neural network models using supervised learning include reverse propagation networks, perceptrons, etc. In unsupervised learning, standard samples are not given in advance, but the network is placed directly in the environment, and the learning and working phases are integrated. At this point, changes in the learning law follow the evolutionary equation of the connection weights. The simplest example of unsupervised learning is the Hebb learning rule. Competitive learning rules are a more complex example of unsupervised learning. It adjusts the weights based on established clusters. Self-organization mapping and adaptive resonance theory network are typical models related to competitive learning.

5 Conclusion

To sum up, more and more people through biomedical materials have been unprecedented feeling, although some people are afraid of the future formation of a robot army to eliminate human beings, but in the present, the material for our lives and society is more beneficial than harmful, so that disabled people get a normal life, so that the dying people to replace organs to continue, compared to the past, we have a lot of new technology, new reasons to live. So, we're working on better biomedical materials for this wonderful society, so we use artificial neural networks to study the principles of proper use and emergency treatment. Above, is the author's theory, if there is anything wrong, please point out.

References

1. Alanis, Alma Y. Electricity Prices Forecasting Using Human Neural Networks. *IEEE Latin America Transactions*, 2018, 16 (1): 105-111.
2. Isik E, Inalli M. Created neural networks and adaptive neuro-fuzzy inference systems approaches to forecast the weather data for HVAC: The case of cities for Turkey. *Energy*, 2018, 154 (JUL.1): 7-16.
3. Safa M, Samarasinghe S, Nejat M. Prediction of Wheat Production Using Humane Neural Networks and Surveying Indirect Factors Affecting It: Case Study in Canterbury Province, New Zealand. *Journal of Agricultural Science and Technology*, 2018, 17 (4): 791-803.
4. Melton D. Advancing Progress in Stem Cells and Biomedicine: 2018-2019 Year in Review. *Stem Cell Reports*, 2019, 12 (6): 1179-1180.

5. Spurlin William J. Queer Theory and Biomedical Practice: The Biomedicalization of Sexuality/The Cultural Politics of Biomedicine. *Journal of Medical Humanities*, 2018, 40:7-20.
6. Jankowski M, Dyszkiewicz-Konwińska, Marta, Budna J, et al. The sourceion and transdifferentiation of epithelial cells in vitro - is it a new strategy in regenerative biomedicine? *Medical Journal of Cell Biology*, 2018, 6 (1): 27-32.
7. Shi C, Yao J, Wang X, et al. A triplet state energy transfer material design concept enables enhanced visualization applications. *Journal of Materials Chemistry C*, 2019, 7 (45): 14170-14180.
8. Hou W, Yang X, Zhang W, et al. Design of energy-dissipating structure with functionally graded auxetic cellular material. *International Journal of Crashworthiness*, 2018, 23 (4): 366-376.
9. Murat, xdc, nal, et al. Thermal buffering effect of a packaging design with microencapsulated phase change material. *International Journal of Energy Research*, 2019, 43 (9): 4495-4505.
10. Lee L, Petter S, Fayard D, et al. On the use of partial least squares path modeling in accounting research *International Journal of Accounting Information Systems*, 2018, 12 (4): 305-328.