Research on the Prediction of the Number of Nuclear Weapons in the World in the Future Based on NAR Neural Network Model

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Abstract. The issues connected with nuclear weapons are closely related to the survival of mankind. Nuclear weapons pose a great threat to world security, human health, the Earth's environment, and other aspects. This paper conducted an investigation and mathematical analysis on the research and development of nuclear weapons in each country, its stockpiles, the number of nuclear tests and the attitude of each country towards nuclear weapons research and development. In order to predict the number of nuclear-weapon countries in the next 100 years, this study can use the number of nuclear-weapon countries in 1938 to 2022 and the number of nuclear weapons in each country in the inventory table to establish a simple sequence prediction neural network, and use the prediction method of NAR neural network model to finally get the change trend of the number of nuclear-weapon countries and the number of nuclear weapons.Finally, it was concluded that the countries with nuclear weapons in 100 years would still be the nine countries with nuclear weapons today, and the total number of nuclear weapons dropped to 8,787. China, France, India, Israel, North Korea, Pakistan, Russia, the United Kingdom, and the United States respectively have 312, 271, 135, 74, 16, 151, 3,745, 161, and 3,922 nuclear weapons in 2123.

Keywords: Nuclear weapons, NAR neural network model, World security.

1. Introduction

Nuclear weapons are one of the most powerful weapons in human history. The earth is the home for human survival, and to protect the earth is to protect all mankind.The instantaneous explosion temperature of the atomic bomb can reach tens of millions of degrees. The explosion equivalent of the atomic bomb is about tens of thousands to hundreds of thousands of tons of TNT equivalent. The explosion of the atomic bomb and its radiation area can destroy a city.

Because of the terrible power of the atomic bomb, many countries hope to use it to deter other countries and protect themselves from foreign invasion. Nuclear weapons have had a profound impact on international relations since their birth, and they have profoundly affected international security for only a few decades[1]. Nuclear weapons are the cornerstone of national security for some major powers in the world. The security relationship built by nuclear-weapon countries around nuclear weapons has also become the ballast stone of the current international security pattern[2-3].

After World War II, all countries in the world began to study and manufacture atomic bombs crazily, and even produced destructive weapons such as the "Great Ivan". During the Cold War, as an important tool for safeguarding national security, nuclear weapons played an important role in the United States' policy towards the Soviet Union[4].

Therefore, In order to protect the common home of mankind,it is very necessary to control the total number of nuclear weapons in the world.

Based on the changes in the number of nuclear-weapon States from 1938 to 2022 and the number of nuclear weapons in the world from 1945 to 2022, this study predicts the number of nuclear weapons in each country, the number of nuclear-weapon States in the next 100 years and the total number of nuclear weapons in the world after 100 years.

2. Materials and methods

2.1. Data acquisition

In order to predict the number of nuclear weapons more accurately, this study crawls some data of APMCM competition question E in 2022. (https://www.saikr.com/c/nd/10852)

When classifying the data, this study found that the number of nuclear tests from 2020 to 2022 was missing. A review of the literature shows that on September 10, 1996, the United Nations General Assembly adopted the *Comprehensive Nuclear-Test-Ban Treaty* by an overwhelming vote of 158 in favour, 3 against and 5 abstentions. Many countries have greatly reduced the number of nuclear tests. With the exception of North Korea, the number of nuclear tests by other nuclear-weapon States was 0. Therefore, in order to establish a more reasonable model, we consider using the mode 0 of test times to interpolate the unknown data, so as to make the analysis results as reasonable and accurate as possible.

2.2. Method introduction

2.2.1 Introduction to artificial neural network

The development and evolution of anything and the study of its laws are all achieved through the unremitting efforts of generations. It is because of the progress of science and technology of the times and the needs of human beings that we continue to make progress. Now is the age of artificial intelligence network data. All fields it covers reflect that the emergence of artificial neural network is the ultimate embodiment of people's development of their own brain structure and function. At the early stage, artificial neural network was imitating the mathematical model of biological brain for information calculation. Its most fundamental is that the computer can use algorithms to quickly and timely process complex data sets, classify, or predict, and obtain accurate results after feedback. Most of them have the functions of self-learning, adaptive, nonlinear, non-convex, high-speed optimization and so on. In front of powerful mathematical algorithms, human computing is very weak. So far, there are many kinds of artificial neural network models, such as BP neural network, RBF neural network, NAR neural network. While developing at a high speed, scholars are trying to improve the accuracy by studying the effect of the change of algorithm parameters on the model itself.

At present, all kinds of applications, such as face recognition, automatic parking, smart phones, can not be separated from artificial intelligence, and the building of artificial intelligence can not be separated from the artificial neural network model. I believe that the development of artificial neural network will also get a qualitative leap through more in-depth research by scholars and the progress of science and technology in the era of big data[5].

2.2.2 NAR neural network

Neural network algorithm is a mathematical model inspired by biological neural system and has strong nonlinear mapping ability. It can better represent the complex relationship between data, has good data processing ability and low requirements for the quality of sample data, and is flexible in operation. Therefore, it has been widely used in data processing and calculation [6]. NAR neural network is a dynamic neural network model for analyzing time series. Essentially, the time series itself is used as the regression variable, and the variable value at a later time is expressed by the linear combination of the variable values within a period of time.

In the process of information transmission, NAR neural network will feed back to the upper layer and participate in the calculation of the next layer. Therefore, its output is not only a static mapping, but also a comprehensive utilization of previous dynamic results. NAR neural network has been widely used in the field of time series analysis and prediction since it was proposed[7].

NAR neural network is called nonlinear autoregressive model, which belongs to a kind of dynamic neural network. The variable relationship between the input and output of the model is not just a static mapping. The output of each moment is synthesized based on the dynamic results of the system before the current moment, that is, it has the function of feedback and memory. The neural network has the

characteristics of dynamic and complete system information at the same time. Therefore, NAR neural network not only inherits the advantages of traditional time series model, but also has better adaptability and prediction effect for nonlinear data [8].

The model of NAR neural network can be described as:

$$Y(t) = f(y(t-1), y(t-2), y(t-3), \ldots, y(t-d)) \quad (1)$$

Where Y(t) is the variable value at the current time; (y(t-1), y(t-2), y(t-3),..., y(t-d) are the variable values at the historical time; D is the delay order.

Generally, NAR neural network consists of static neurons and network output feedback. A complete NAR neural network is generally composed of input layer, hidden layer, and output layer. As shown in Figure 1, data y(t) enters from the input layer, enters the hidden layer, and reaches the output layer after training, transmission, and learning, thus obtaining the prediction results.

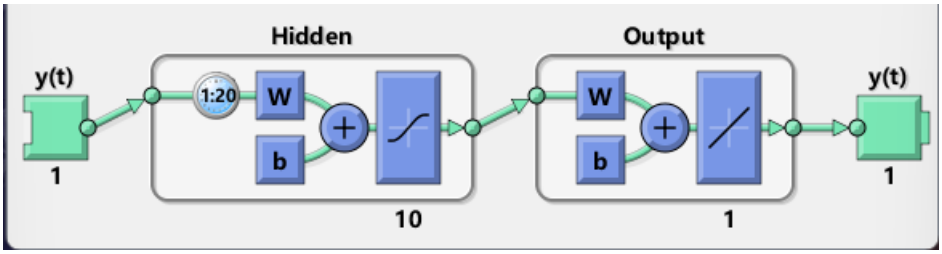

Figure 1. Structure diagram of NAR neural network

In the figure 1, y(t) represents the input of the neural network; 1:20 in the hidden layer is the delay order, which means that the value of a point in the time series is predicted by using the three points before the point; W is the connection right and b is the threshold.

The delay order of the NAR neural network constructed in this paper is 20, that is, the first 20 points of a point in the time series are used to predict the value of that point, and the number of neurons in the hidden layer is 10.

Each neuron output can be expressed as:

$$H_i = f\left(\sum_{i=1}^{n} w_{ij} y_i + b_j\right) \quad (2)$$

Where is the activation function; is the connection weight between the ith output delay signal and the jth neuron in the hidden layer.

3. Results

3.1. Modeling ideas and model establishment

It can be seen that this problem belongs to the category of prediction. Because it is necessary to predict the countries with nuclear weapons in the next 100 years and the time span is large, it is decided to use the NAR neural network model for prediction. This study uses the known data of the previous n years to predict (n+1) data. The training set uses the data of the number of nuclear-weapon States from 1938 to 2022. This data set is used to predict the number of countries with nuclear weapons in the next 100 years.

Firstly, the number of nuclear weapons in each country in the inventory is analyzed, and then the change of the number of nuclear weapons in the world from 1945 to 2022 is statistically analyzed.

Then this study will predict the number of nuclear weapons in each country with nuclear weapons in the next 100 years, as well as the number of nuclear weapons they have in 2123 years. At the same time, the neural network model of data analysis is established using matlab. The model uses data on the number of nuclear weapons of the former nuclear powers from 1945 to 2022 and the total number of nuclear weapons from 1945 to 2022.

3.2. Factor analysis

(1) Assuming that there will be no significant change in a short term in the countries which have not considered nuclear weapons since 1996.

(2) Using data only from countries with nuclear weapons, regardless of their economic strength, industrial base and strategic needs of individual States.

(3) Assuming that there will be no major turbulence in the world pattern and that the pattern of "only super power and multi-great power" will be maintained.

(4) There will be no major changes in the international situation in the next 100 years, and a tense international situation such as a bipolar pattern will not emerge.

3.3. The results predicted by the model

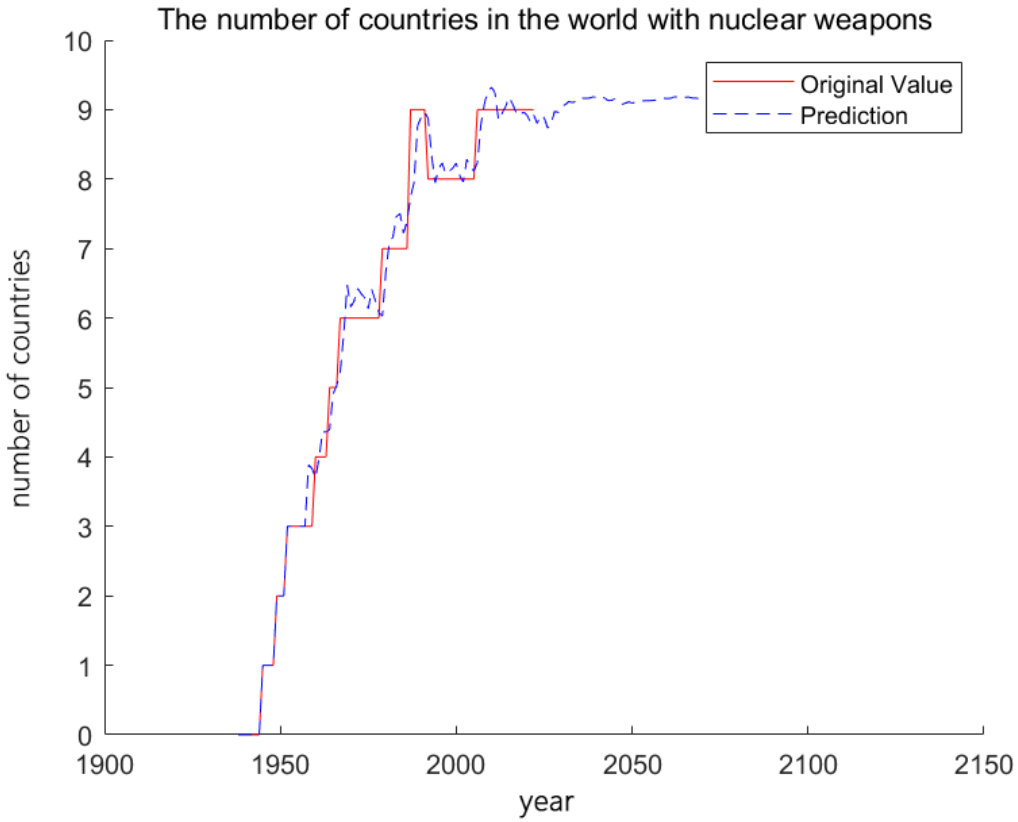

Figure 2. A prediction of the number of countries with nuclear weapons

As shown in Figure 2, since the United States began to possess nuclear weapons in 1945, the number of countries possessing nuclear weapons has soared. In 1998, the number of countries possessing nuclear weapons reached the highest level. According to the prediction, the number of countries with nuclear weapons in the next 100 years will remain roughly the same, the number of countries with nuclear weapons in the future will remain nine. This is because the model uses the number of countries with nuclear weapons from 1938 to 2022 and lacks some other factors.

This study should take the Comprehensive Nuclear-Test-Ban Treaty adopted by the United Nations General Assembly on 10 September 1996 into account[9]. It is an international treaty aimed at prohibiting all States parties from carrying out any nuclear explosion anywhere, in order to effectively contribute to the comprehensive prevention of the proliferation of nuclear weapons, to the process of nuclear disarmament and to the enhancement of international peace and security. So it means that many country parties have not tested nuclear weapons since then. This will have an impact on nations that have not yet developed nuclear weapons, making it more difficult to do so. On the political level, it is very difficult to develop nuclear weapons in a political environment where the United States sanctions all countries that develop nuclear weapons, and countries like Iran have been sanctioned before. From our point of view, this model is basically consistent with reality.

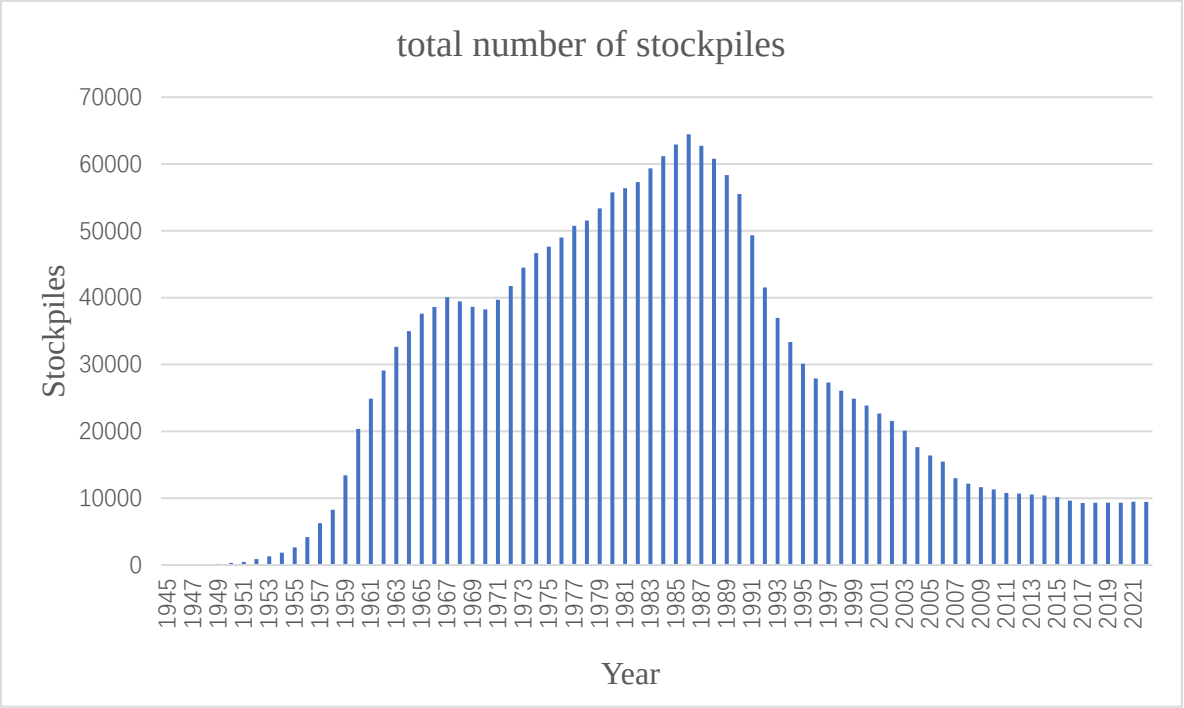

Figure 3. Total number of nuclear stockpiles

As shown in Figure 3, the global total of nuclear weapons revealed an overall trend of first rising and then declining, reaching a peak in 1986. The dramatic increase in the number of nuclear weapons around the world came during the Cold War, when the United States and the Soviet Union were engaged in a fierce arms race, and both countries continued to build nuclear weapons in that period. It was not until the collapse of the bipolar structure that the number of nuclear weapons in both Russia and the United States began to decline significantly, which led to a significant downward trend in the number of nuclear weapons in the world. Since the international situation has generally stabilized since the cold war, data since 1991 should be more representative. In addition, the *Comprehensive Nuclear-Test-Ban Treaty*, which was adopted in 1996, will make it harder for States that have not built nuclear weapons to develop them.

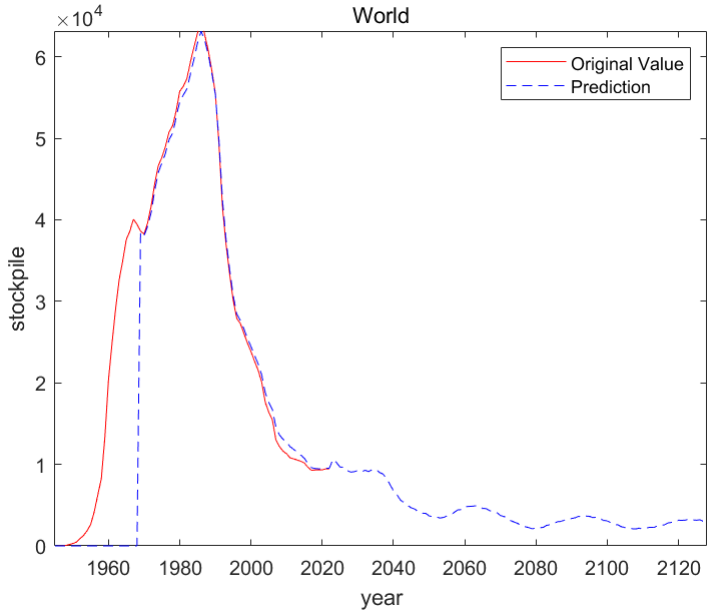

Figure 4. Projections of changes in the number of nuclear weapons worldwide

Then import data from the inventory in the data set, and use matlab to process the data. After training and prediction, the following results are obtained, as shown in Figure 4. It is not difficult

to see that there is an overall downward trend in the number of nuclear weapons in the next 100 years, but there will be fluctuations, not constant declines.

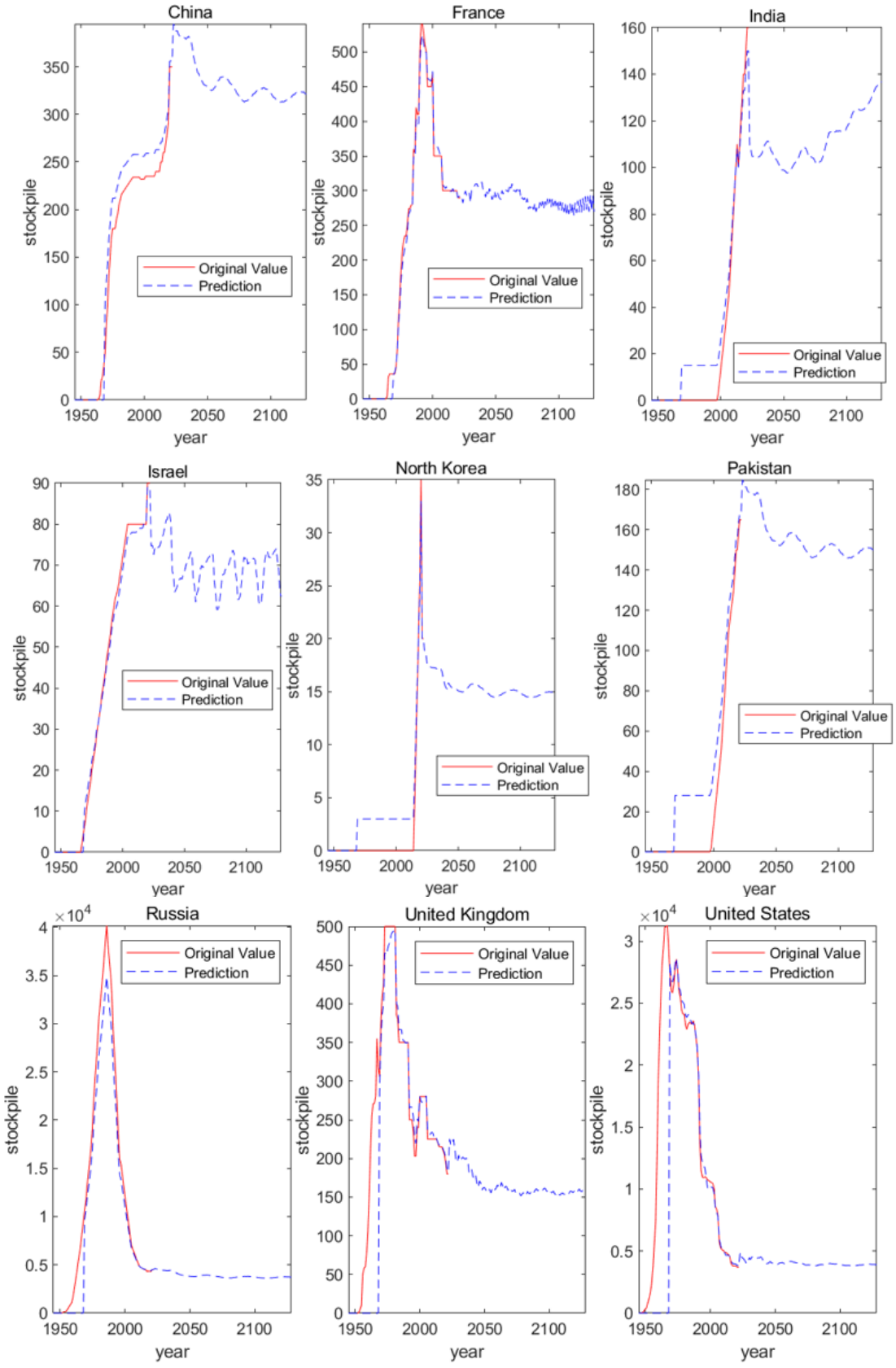

Figure 5. Forecast number of nuclear weapons by country

As shown in Figure 5, China is predicted to have 312 nuclear weapons in 2123; France will have 271 nuclear weapons in 2123; India will have 135, Israel will have 74; and North Korea will have 16;

Pakistan will have 151; Russia will have 3,745; South Africa will have 0; the United Kingdom will have 161; and the United States will have 3,922.

This gives a total of 8,787 nuclear weapons in 2123. The projections are in line with a downward trend in the total number of nuclear weapons.

The security of nuclear weapons should not be underestimated. At the national level, the proliferation of nuclear weapons belongs to the traditional security category, which belongs to the traditional security scope of the country's pursuit of military capabilities. However, after entering the sub-national or even non-national level, the proliferation of nuclear weapons will lead to a serious imbalance in the international security order, and its destructive force is unimaginable[10].

4. Conclusions

Through the establishment of the model, the predicted result of this paper is that in the next 100 years, there are still nine countries with nuclear weapons that currently possess nuclear weapons, and these nine countries will have smaller nuclear reserves in the next 100 years, and the total nuclear reserves in the world will decrease.It was concluded that the countries with nuclear weapons in 100 years would still be the nine countries with nuclear weapons today, and the total number of nuclear weapons dropped to 8,787. China, France, India, Israel, North Korea, Pakistan, Russia, the United Kingdom, and the United States respectively have 312, 271, 135, 74, 16, 151, 3,745, 161, and 3,922 nuclear weapons in 2123.

We call on the countries that already possess nuclear weapons to complete prohibition and gradual destruction of nuclear weapons, stop nuclear proliferation, promote nuclear disarmament and promote international cooperation in the peaceful use of nuclear energy. Countries that do not possess nuclear weapons should live in peace and establish friendly relations with other countries, improve their scientific research and strike a balance in light of their national conditions.

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