Team Number:	2213172
Problem Chosen:	E

2023 APMCM summary sheet

On August 6, 1945, ”Little Boy” killed 200,000 people in Hiroshima, and all the buildings in Hiroshima collapsed. People became aware of the terrible power of the atomic bomb and prepared nuclear weapons to defend themselves or to deter other countries. But people were more worried about the safety of the earth and themselves, and we have completed the questions based on the annexes and related data.

After processing the attached data, we get that China, France, India, Israel, North Korea, Pakistan, Russia, South Africa, the United Kingdom and the United States are the ten countries that once possessed nuclear weapons; The United States has seen the largest reduction in its stockpile of nuclear weapons over the past 20 years; Between 1962 and 1966, the world conducted the most nuclear weapons tests; North Korea has been the most active in nuclear weapons research over the past decade; The United States has made the fastest transition from ”not considering nuclear weapons” to ”possessing nuclear weapons.。

Model II, The BP neural network model about the number of nuclear weapons is built directly for 9 countries with nuclear weapons. For other countries, relevant data are collected to form four indicators: GDP, per capita GDP, military expenditure as a percentage of GDP and absolute military expenditure, and these four indicators are input as neural networks to make predictions. After solving the model, nine countries including China and France will possess nuclear weapons in the next 100 years. As for the number of nuclear weapons in the next 100 years, the neural network model is also used to solve the problem, and it is concluded that the number of nuclear weapons in the world will decline slowly in the next 100 years, reaching 7,830 in 2123. The number of nuclear weapons in 2123 by the nine nuclear-armed states: 361 for China and 3,803 for the United States, as shown in Table 4. In all but nine countries, it was 0.

Model III, we first solve the explosion location of nuclear weapons through a multi-objective optimization model, and then optimize it through particle swarm algorithm to get the optimal solution, taking Vietnam as an example, using the model to cover the entire territory of Vietnam requires 25 tsarist bombs and has nuclear weapon detonation coordinates. This paper concludes that 3689 Tsarist bombs are needed to destroy the Earth, and the global nuclear bombs cannot destroy the Earth combined, but they can also cause a lot of damage, and finally this paper considers that the total number of nuclear bombs is controlled at 708∼ 944 bombs is more stable, and proposes an allocation scheme as shown in Table5.

For question four, we wrote a non-technical article describing our findings and making some recommendations for countries around the world to keep the peace.

Finally, our team summarizes the strengths and weaknesses of the model and provides an outlook on the future of the model.

Keywords: BP Neural Network   Time Series Forecasting   Particle swarm algorithm

Contents

I. Introduction

1.1 Problem Background

On August 6, 1945, the Second World War was drawing to a close. In order to end the war as soon as possible, the United States dropped the next atomic bomb called "Little Boy" in Hiroshima, Japan. Such an atomic bomb killed 200000 people in Hiroshima, and all buildings in Hiroshima collapsed. This is the first time in human history that the atomic bomb has been put into practice, and it also makes many people realize the terrible power of the atomic bomb for the first time.There are many kinds of nuclear weapons,The "Big Ivan" is the most powerful nuclear bomb known in the world at present, that is, the "czar bomb" built in the Soviet period.In order for mankind to better understand nuclear weapons, it is necessary to develop mathematical models to conduct basic data studies on nuclear weapons, predictions on the number of nuclear weapons and studies related to how many nuclear weapons will destroy the Earth.

Figure 1 : Nuclear Bombs Research

(a)**Nuclear Weapons**:Nuclear weapons refer to huge lethal weapons related to nuclear reaction, including hydrogen bombs, atomic bombs, neutron bombs, etc. Nuclear weapons are one of the most powerful weapons ever developed by human beings, and they often remind people of the scene of destroying heaven and earth. The instantaneous explosion temperature of an atomic bomb can reach tens of millions of degrees. The explosive yield of the atomic bomb is about tens of thousands to hundreds of thousands of tons of TNT equivalent. The explosion of an atomic bomb and the area of its radiation can destroy a city.

(b)**Czar Bomb**:The data shows that its length is 8 meters, diameter is 2.1 meters, weight is up to 27 tons, and design TNT equivalent is 50 megatons. The Soviet Union originally planned to design an equivalent of 100 megatons, but because the destructive force was too great to find a suitable test site, the power was reduced by half. Even so, the Czar Bomb is still the most powerful nuclear weapon in the world. The explosive power of the "little boy" is about 14000 tons of TNT equivalent, making Hiroshima a ruin, while the power of the "tsar bomb" is comparable to dozens or even hundreds of "little boys".

1.2 Restatement of the Problem

We need to build a model that can perform basic data studies on existing nuclear weapons, predict the number of nuclear weapons and how many nuclear weapons will destroy the Earth. The model is applicable to any type of period and meets the following conditions:

- Basic data analysis

- ★ Which countries have ever possessed nuclear weapons?
- ★ Which country has the largest reduction or increase in its nuclear weapons stockpiles in the last 20 years?
- ★ During which five years did nuclear weapon tests occur the most?
- ★ Which country has been the most active in nuclear weapons research in the last 10 years?
- ★ Which country has made the fastest transition from ”not considering nuclear weapons” to ”possessing nuclear weapons”?

- Predict the number of nuclear weapons
  - ★ According to the attached data or the data you collected, establish a mathematical model to predict the number of nuclear weapons, and predict the countries with nuclear weapons in the next 100 years;
  - ★ Predict the change trend of the number of nuclear weapons in the next 100 years, the total number of nuclear weapons in 2123, and the number of nuclear weapons in each country.
- Protect our planet
  - ★ Establish an mathematical model for the detonation position of nuclear weapons, and calculate how many nuclear bombs are required at least to destroy the earth?
  - ★ According to the mathematical model, what is the maximum destructive power of the nuclear bomb currently possessed? Is it enough to destroy the earth?
  - ★ In order to protect the earth and the environment on which we live, what should the total number of nuclear bombs in the world be limited to, and what should the countries that already have nuclear weapons be limited to theoretically?
- Prepare a non-technical article (1 page maximum). Please write a non-technical article (1 page at most) to the United Nations (U.N.), explaining your team’s findings and putting forward several suggestions for all countries.

1 . 3 Literature Review

This question focuses on the prediction of the number of nuclear weapons and the prediction of the power of nuclear weapons, and the topic requires the prediction of the number of nuclear weapons and the prediction of the power of nuclear weapons globally and for different countries. In recent years, there have been more studies on the prediction of the number of nuclear weapons and less published information on the prediction of the power of nuclear weapons. In general, the number of nuclear weapons can be predicted by considering both the economic and industrial levels, and the power of nuclear weapons can be estimated by the TNT equivalent.this section mainly discusses the models that have been proposed.

- ★ First of all, in terms of influencing factors: In Zhang Li-kun [1] divide Number of nuclear weapons into three types: National strategy, economy and international environment. In order to be more professional, more authors divide riders into four types: National strategy, economy, international environment and industrial level.
- ★ Secondly,Based on the available data, the researchers obtained a link between the TNT equivalent of nuclear weapons and lethality.

  The research process of scholars can be presented intuitively, as shown in the following figure:

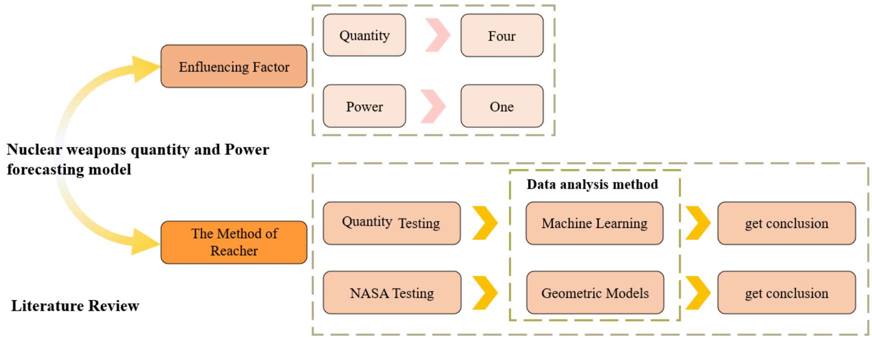

Figure 2 Literature Review Framework

1.4 Overview of our work

This problem requires us to build a predictive model of the number and power of nuclear weapons that can be applied to different years and countries from the annex data.Our work mainly includes the following:

- ► Solved the first question using mathematical knowledge and knowledge of nuclear weapons.
- ► A BP neural network model of influencing factors and years based on a country's economic level as well as its industrial level.
- ► Gives methods and suggestions to address the problem.
- ► Use of nuclear weapon power prediction models in three different application scenarios.
- ► Developed a mathematical and physics-based model for predicting the power of nuclear weapons.
- ► Gave a report on the long-term development of nuclear weapons and extended the model in the text to the report to get a report that can be understood by non-specialists

In order to avoid complicated description, intuitively reflect our work process, the flow chart is shown in 3:

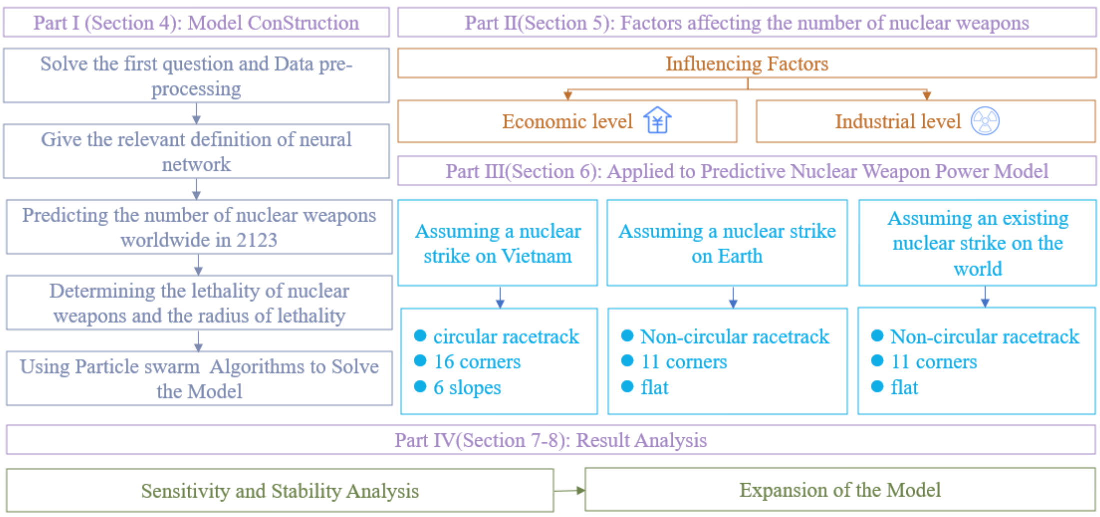

Figure 3 Flow Chart of Our Work

II. Assumptions and Explanations

Considering that practical problems always contain many complex factors, first of all, we need to make reasonable assumptions to simplify the model, and each hypothesis is closely followed by its corresponding explanation:

- **Assumption 1: Assume that there are no accidents such as collision, malfunction, damage, etc. occurs during the destruction of the target by the nuclear bomb.**
  Explanation: Although some accidents are inevitable in real situations, and even nuclear weapons may choose to terminate their missions for these reasons, which can have a significant impact on the overall nuclear launch program, the occurrence of these situations is a small probability event. Therefore, we do not discuss it in this paper.
- **Assumption 2: It is assumed that the nuclear weapon has a suitable climate during the launch, and there are no disturbing factors such as rain, fog and haze.**
  Explanation: Usually the launch of nuclear weapons is held when the weather is suitable, but sometimes it is inevitable that after the launch starts, there may be rain, wind and other weather, but when the intensity is not high, the effect on nuclear weapons is almost negligible.
- **Assumption 3:It is assumed that the power and lethality of 1 Tsar bomb is equivalent to 6-8 nuclear bombs in the annex in all aspects.**
  Explanation: Because it is convenient for the later calculations not to consider the gap between Tsarist bombs and multiple nuclear bombs, but the fact that there is still a large difference between the two, the model in this paper does not consider this factor for the time being.
- **Assumption 4:Assuming that the data provided in the annex is true and reliable.**
  Explanation: The data in the topic are often very critical, and the model in this paper is based on these data, and the authenticity of the data is not considered for the time being, and all data are considered real and reliable.

III. Notations

Some important mathematical notations used in this paper are listed in Table .

textbfSymbol	textbfDescription	textbfUnit
R	Kill radius	KM
C	Proportional constants	
D	TNT explosion equivalent	KJ

Note: There are some variables that are not listed here and will be discussed in detail in each section.

IV. Basic data analysis

a) Which countries have ever possessed nuclear weapons?

According to the analysis of the data in the annex on each country's stockpile of nuclear weapons over the years, States that have stockpiled at least one nuclear weapon over the years are referred to as former nuclear-weapon States. States that once possessed nuclear weapons are listed as below1shown：

Table 1 Countries that once possessed nuclear weapons

Country	China	France	India	Israel	North Korea
	Pakistan	Russia	South Africa	United Kingdom	United States

b) Which country has the largest reduction or increase in its nuclear weapons stockpiles in the last 20 years?

Use the data in the annex to plot the trend of each country's nuclear weapons stockpile4show, America is the answer. As can be seen from the chart, the United States and Russia have seen the

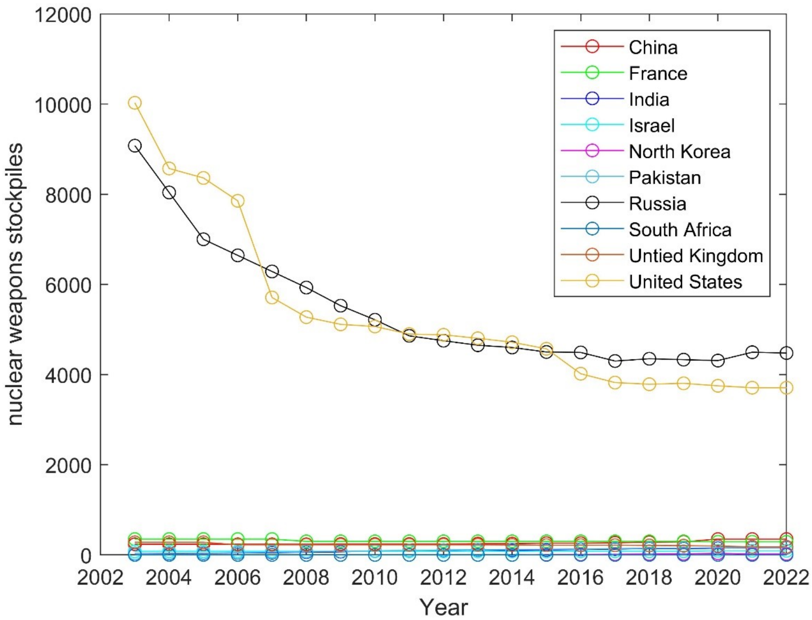

Figure 4 : Changes in nuclear weapons stocks

most significant changes in their nuclear stockpiles; Among them, the United States has reduced the number of nuclear weapons the most. Between 2003 and 2022, the United States has reduced the number of nuclear weapons the most by 63.02% compared to 6,319.

c) During which five years did nuclear weapon tests occur the most?

According to the data in the annex, the number of nuclear weapon tests conducted by each country in each year is counted, and the global number of nuclear weapon tests conducted in each five years is shown in the figure5 (horizontal axis represents the first year of each five years) ,

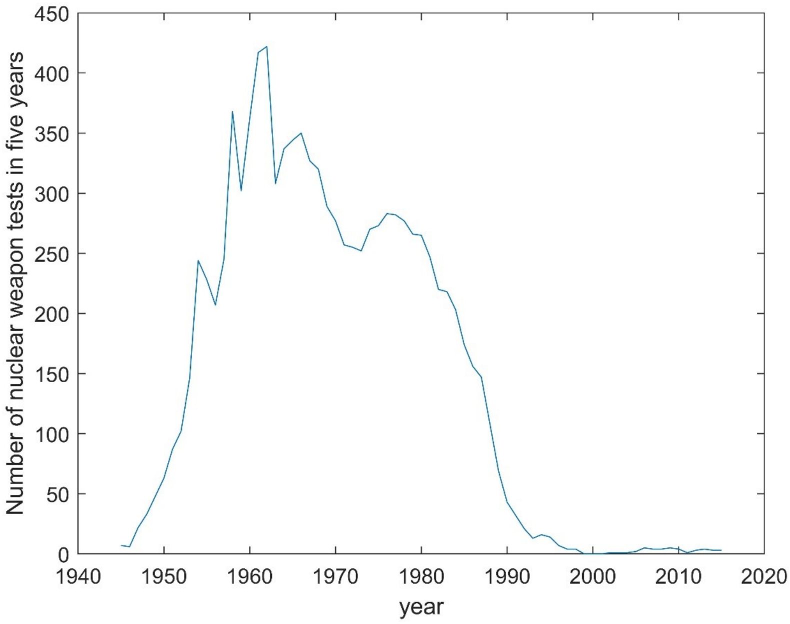

Figure 5 : Number of nuclear weapon tests worldwide

The number of nuclear weapons tested worldwide 1962 to 1966 is the answer. During the five years, the number of nuclear weapon tests worldwide was 422, the highest number of nuclear weapon tests conducted by any country for five consecutive years. The detailed number of global nuclear weapons tests for each five-year period from 1945 to 2022 is shown in the appendix.

d) Which country has been the most active in nuclear weapons research in the last 10 years? In the past ten years, that is, from 2013 to 2022, nuclear weapon states are extracted from the annex. The total number of nuclear weapon tests conducted in these countries during this period is analyzed, as shown in the table2, to reflect the degree of countries' activity in nuclear weapon research. North

Table 2 Number of nuclear weapons tests in the last decade

Country	China	France	India	North Korea	Pakistan
Test Sum	0	0	0	4	0
Country	Russia	United Kingdom	United States		
Test Sum	0	0	0		

Korea is the most active country in nuclear weapons research.

Because the highest record year for the data of nuclear weapon tests of all countries in the annex is 2019, if the country with the most active nuclear weapon research in the world is calculated from 2010 to 2019, the result is still North Korea. The number of nuclear weapons tests conducted by the country during the decade was seven, compared with zero for all other countries, making North Korea the most active country in nuclear weapons research.

e) Which country has made the fastest transition from ”not considering nuclear weapons” to ”possessing nuclear weapons”?

Until 1938, countries did not consider nuclear weapons. Analysis of the data in the Annex gives the number of years it took for countries to move from ”not considering nuclear weapons” to ”possessing nuclear weapons” in the following table3 The United States was the fastest transforming

Table 3 Transition Time

Country	China	France	India	Israel	North Korea
years	13	16	40	19	45
Country	Pakistan	Russia	South Africa	United Kingdom	United States
years	16	8	11	13	7

country, taking only seven years to complete the transformation.

V. Nuclear weapons quantity forecasting model

5.1 A neural network-based model for predicting the number of nuclear weapons

The analysis of the base data shows that there are nine countries that currently possess nuclear weapons, and of the rest, only countries that are currently pursuing nuclear weapons and those that have pursued them before are analyzed. For the countries that have not pursued nuclear weapons, it is believed that they will still not possess nuclear weapons in the future. Because the development of nuclear weapons is much more difficult after the adoption of the Comprehensive Nuclear Test Ban Treaty at the United Nations General Assembly on September 10, 1996, and because it is assumed that these countries will not suddenly become powerful in a certain period of time in the future, the countries that have not pursued nuclear weapons before are not considered.

Predicting the number of nuclear weapons in countries with nuclear weapons and other countries, respectively, for the nine countries with nuclear weapons, the neural network algorithm is directly used for network training, and its general network is shown in Figure 6. Where the year is used as the input of the network and the number of nuclear weapons is used as the output of the network, the input signal is processed from the input layer through the implicit layer layer by layer until the output layer, and each layer of neurons only affects the state of the neurons in the next layer. If the output does not get the desired output, it is transferred to back propagation.

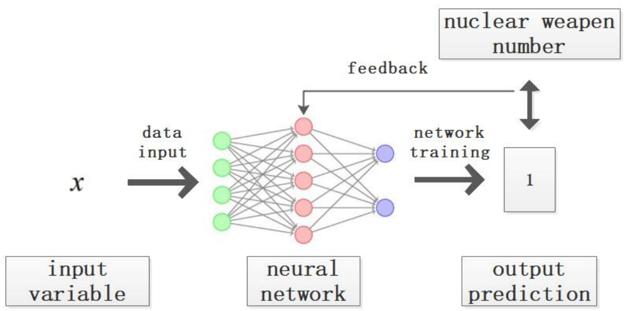

Figure 6 Neural network structure diagram

The number of nuclear weapons for the other countries is 0. Therefore, the number of nuclear weapons cannot be used as a variable for direct prediction, and other data need to be added. These four indicators are added here: GDP, GDP per capita, military expenditure (as a percentage of GDP), and military expenditure. The final countries to be analyzed are Iran, Syria, and South Korea, because the data from 1960 onwards are only available due to statistical techniques and information flow, and because some countries have too little data to support the completion of the forecast. quantity as the output of the network.

The specific neural network steps are as follows.

Step 1: Network initialization. Determine the number of nodes n in the input layer, I in the implicit layer and m in the output layer, initialize the connection weights w_{ij} between neurons in the input, implicit and output layers, w_{jk} initialize the threshold a in the implicit layer and b in the output layer, and give the learning rate and neuron excitation function.

Step 2: Implicit layer output calculation. Based on the input variable X, the connection weights w_{ij} of the input and hidden layers and the implicit layer threshold a, the implicit layer output H is calculated.

$$H_j = f\left(\sum_{i=1}^{n} \omega_{ij} x_i - a_j\right) \quad j = 1, 2, \cdots\cdots l \tag{1}$$

where l is the number of nodes in the hidden layer; f is the hidden layer excitation function, which has various expressions, of which in which the default excitation function is:

$$f(x) = \frac{1}{1 + e^{-x}} \tag{2}$$

Step 3: Output layer calculation. Based on the output H of the hidden layer, connect the weights w_{jk} and the threshold b to calculate the BP neural network prediction O_K.

$$O_k = \sum_{j=1}^{l} H\omega_{jk} - b \quad k = 1, 2; \cdots m \tag{3}$$

Step 4: Error calculation. Based on the network prediction output O and the desired output Y, calculate the network prediction error$e$.

$$e_k = Y_k - O \quad k = 1, 2; m \tag{4}$$

Step 5: Weights update. Update the network connection weights w_{ij}, w_{jk} according to the network prediction error e .

$$\omega_{ij} = \omega_{ij} + \eta H_j \left(1 - H_j\right) x(i) \sum_{k=1}^{m} \omega_{jk} e_k \quad i = 1, 2, \cdots n; \quad j = 1, 2, \cdots\cdots l \tag{5}$$

$$\omega_{jk} = \omega_{jk} + \eta H e_j \quad j = 1, 2, \cdots l \quad k = 1, 2, \cdots m \tag{6}$$

where,η is the learning rate.

Step 6: Threshold update. Update the network node thresholds a, b according to the network prediction error e.

$$a_j = a_j + \eta H_j (1 - H_j) \sum_{k=1}^{m} w_{jk} \tag{7}$$

$$b_k = b_k + e \quad k = 1, 2; \cdot m \tag{8}$$

Step 7: Determine if the iteration of the algorithm is finished, if not, return to Step 2.

5.2 Model solving

The Neural Net Fitting toolbox that comes with Matlab2022a is used to train the data, and the samples are divided into training and testing sets according to the ratio of 70% and 30%. Taking the data from China as an example, the fit of the neural network is shown in Fig. 7.

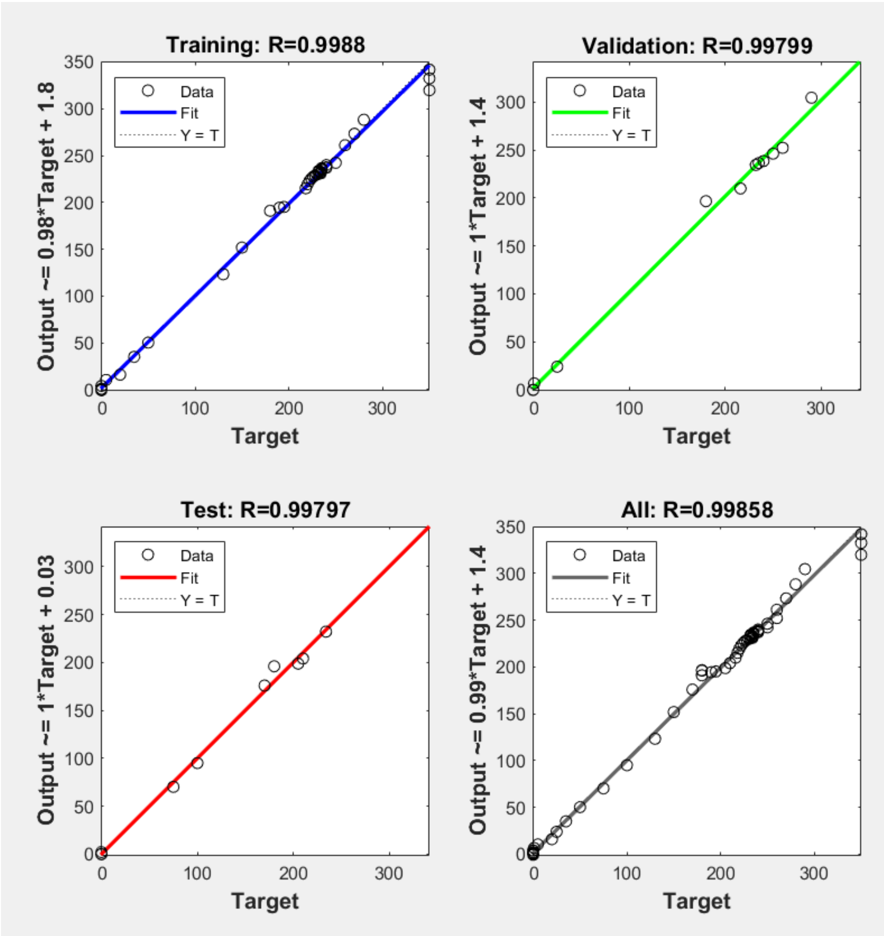

Figure 7 Neural network goodness of fit

The fitted values are regressed on the true values, and the goodness of fit from the graph is high, indicating that the fit is good.

For the nine countries with nuclear weapons, the projections of their nuclear weapons numbers are shown in Figure 8.

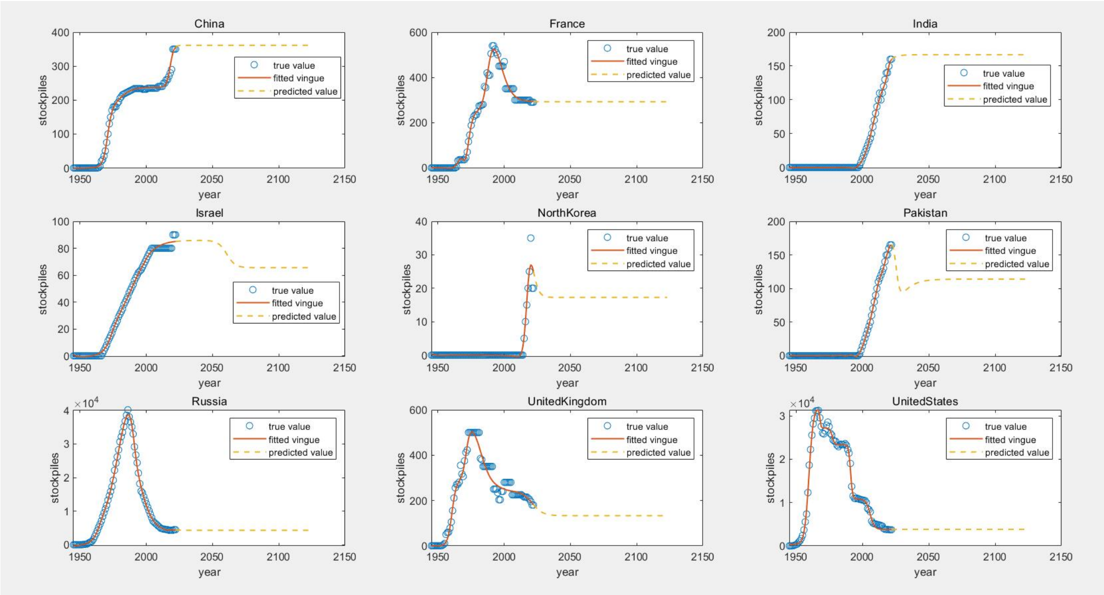

Figure 8 Projections of the number of nuclear weapons in the nine nuclear-armed states

As you can see from the graph, nine countries that have nuclear weapons still have them for the next 100 years.

The number of nuclear weapons in Iran, Syria, and South Korea is shown in Figures 9(a), 9(b), and 9(c).

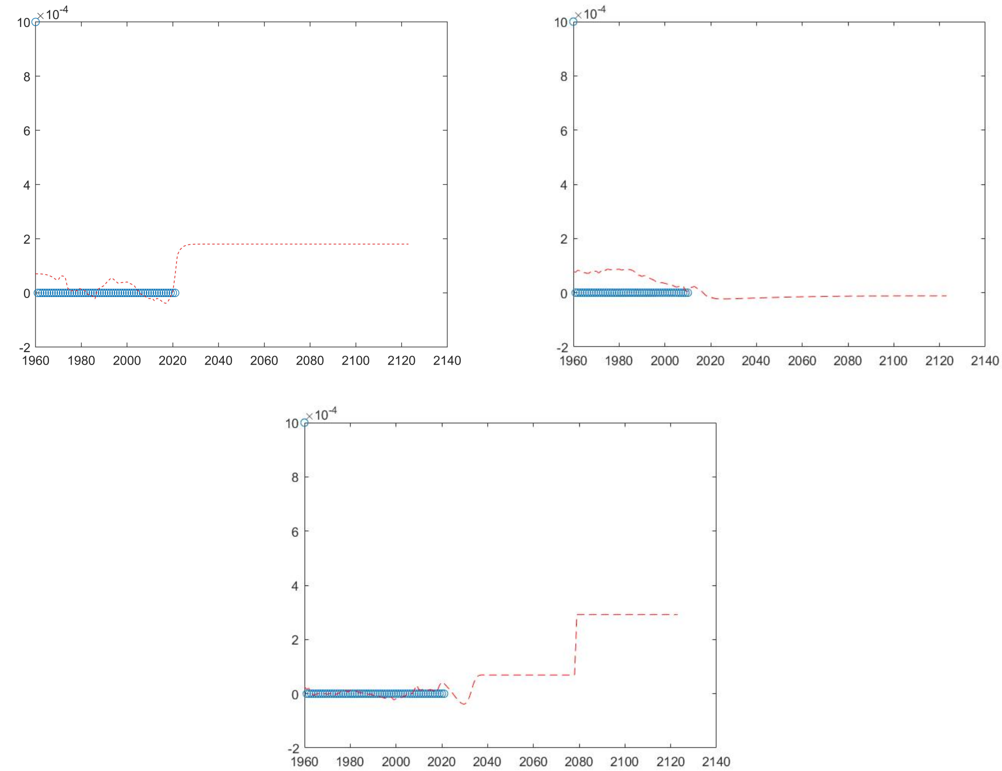

Figure 9 (a)Iran's projected number of nuclear weapons (b)Syria's projected number of nuclear weapons (c)South Korea's projected number of nuclear weapons

 The vertical axis represents the number of nuclear weapons, and as you can see from the graph, these three countries will barely increase the number of nuclear weapons and therefore do not possess them in the next 100 years.

5.3 Number of future nuclear weapons

The number of nuclear weapons of each country in each year is added up, and the year is used as the network input, and the summed result is used as the network output to obtain the result shown in Figure 10.

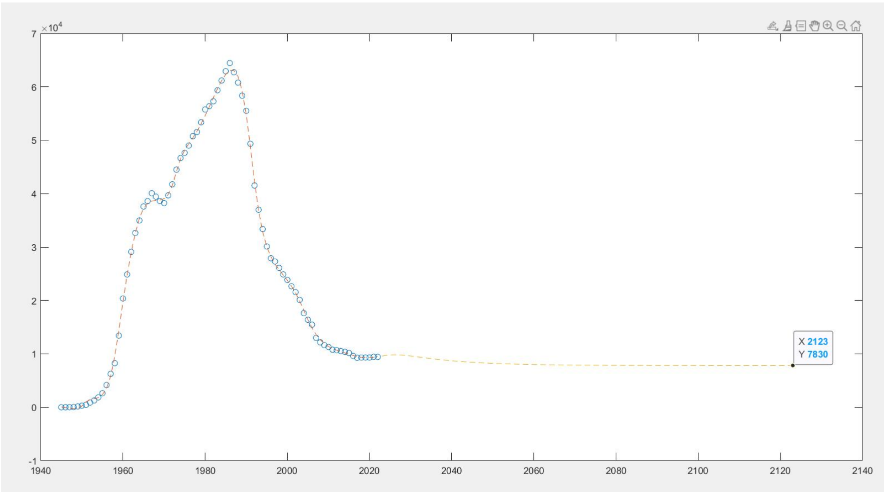

Figure 10 Trends in nuclear weapons numbers over the next 100 years

In the next hundred years, the global trend in the number of nuclear weapons is slowly decreasing, eventually reaching 7830 in 2123. Based on the solution of the above model, the number of nuclear possessions of each country can be derived as shown in the following table 4.

Table 4 The number of nuclear weapons held by nine countries

Country	China	France	India	Israel	North Korea
number	361	292	166	65	17
Country	Pakistan	Russia	United Kingdom	United States	
number	113	4288	132	3803	

VI. Mathematical and physical model of nuclear bomb power

6.1 Estimated nuclear weapon kill range

According to the study by et al, the kill radius of nuclear weapons is

$$R = C \times D^{1/2} \tag{9}$$

Where R is the kill radius, C is the proportionality constant, generally taken as 1.493885, D is the explosion equivalent.

In general, the impact of the explosion on the surrounding area are the center of the explosion has the greatest impact, the impact in descending order, through access to information can be divided into four layers of nuclear weapons explosion “Fireball radius、Moderate blast damage radius、Thermal radiation radius and Light blast damage radius”。

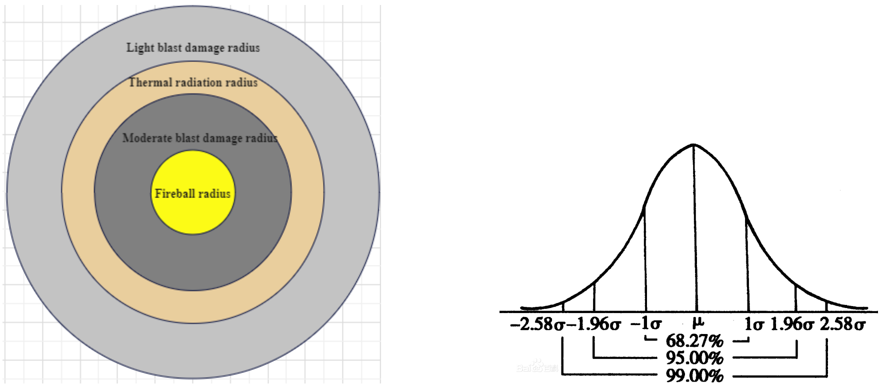

Figure 11 (a): Physical diagram of nuclear weapon explosion (b): Normal distribution density curve

From the perspective of probability theory, the kill pattern of nuclear weapons is more in line with the normal distribution, and the equation of the normal distribution curve, i.e., the probability density function, is known as follows.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-\mu)^2}{2\pi^2}}, x \in R \tag{10}$$

In the standard normal distribution, the mean point of the sample is 0, and the location of x = 0 probability density is the largest, in the impact function of the nuclear weapon explosion, the location is the detonation point of nuclear weapons, but also the location of the largest impact of nuclear weapons, as the distance from the center of the nuclear weapon explosion continues to expand, the impact of nuclear weapons will be reduced, in line with the characteristics of probability theory.

$$\int_{-\infty}^{+\infty} \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-\mu)^2}{2\pi^2}}dx = 1 \tag{11}$$

This paper proposes several special nodes satisfying the following mathematical relations based on the knowledge of probability theory:

$$\begin{cases} P(-2.58\sigma \le x \le 2.58\sigma) = 99.00\% \\ P(-1.95\sigma \le x \le 1.95\sigma) = 95.00\% \\ P(-\sigma \le x \le \sigma) = 68.27\% \end{cases} \tag{12}$$

Then you can get the kill radius of a nuclear weapon.

6.2 Particle swarm-based optimization model for nuclear weapon explosion location

According to the meaning of this paper, the understanding of "destroy the earth" is to destroy the living environment of human beings and living creatures on earth, that is, let the global land suitable for living creatures are covered by the effective killing range of nuclear weapons, the power of nuclear weapons explosion range is usually circular, in real life, in order to better destroy the target and to ensure the number of nuclear bombs, will require the destruction of the target under the premise of spending as little as possible nuclear bombs, and because of the different power of nuclear weapons in different countries, based on the above requirements, this paper set up the goal optimization model as follows.

$$\min \sum_{i=1}^{N} x_i \tag{13}$$

Constraints:

$$\begin{aligned} &(1+\lambda_1) S \leq \sum_{i=1}^{N} p_i x_i \leq (1+\lambda_2) S \\ &0 \leq x_i \leq \text{ num }_i, i=1,2,3,\cdots,N \end{aligned} \tag{14}$$

where x_i denotes the number of nuclear bombs required for the ith country, p_i denotes the kill radius involved in one nuclear bomb, num_i represents the limit of the number of nuclear bombs for the ith country, S denotes the total surface area where a nuclear strike is required, $\lambda_1 = 0.05$, $\lambda_2 = 0.12$ denotes the margin factor, considering There is an overlapping area for the impact range of the nuclear bomb explosion location. Here make the assumption that the survival environment within the kill radius of each nuclear bomb explosion is completely destroyed.

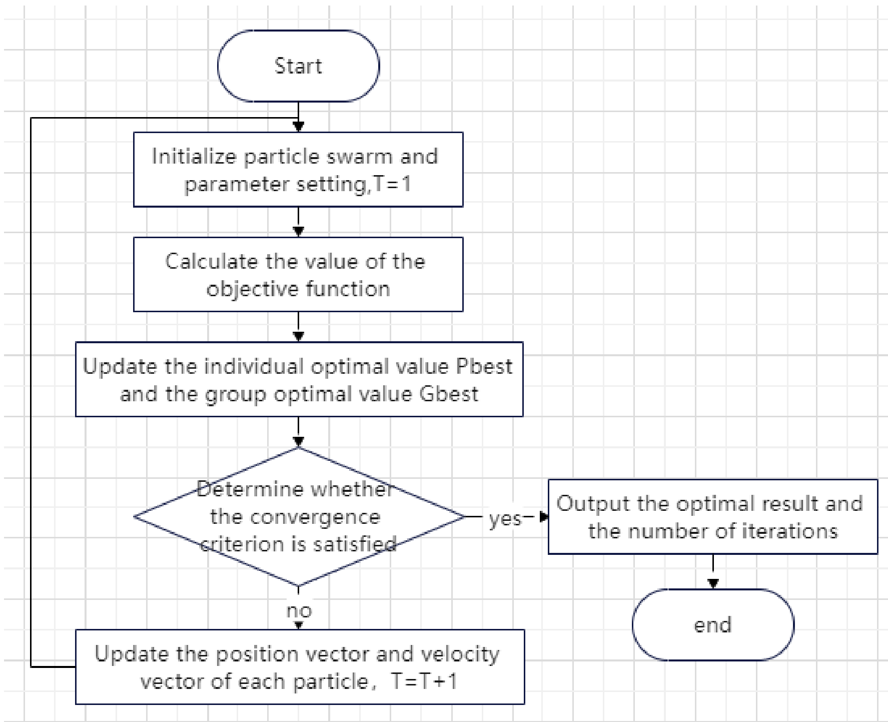

Figure 12 : Particle swarm algorithm flow chart

By calculating the number of nuclear bombs in each country and region from the above steps, it is possible to calculate how many bombs are needed to ”destroy the Earth”.

6.3 Model solving

a) Establish an mathematical model for the detonation position of nuclear weapons, and calculate how many nuclear bombs are required at least to destroy the earth?

The TNT equivalent of the Tsar’s hydrogen bomb is equal to 50 million tons, and the effective killing radius is calculated to be 91.8km, $withakillingareaof$26,450 km^2. In this paper, the center of the city of ”Beijing” is used as the nuclear strike target to make the following figure:

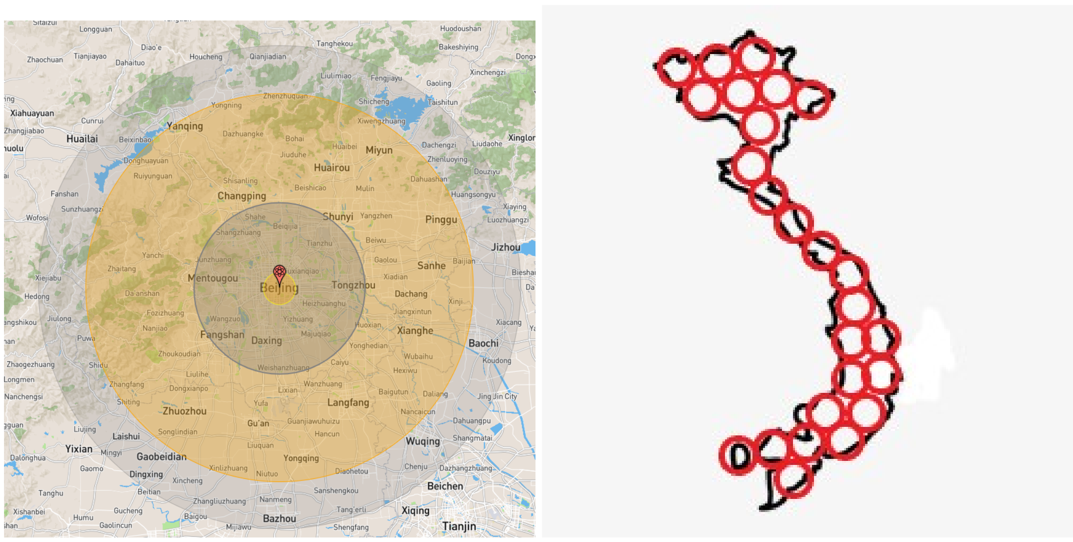

Figure 13 (a) Tsar Bomb’s kill radius on the map (estimated)(b) Hypothetical nuclear weapon locations for a nuclear strike on Vietnam

Vietnam is located in the eastern part of the South Central Peninsula, with an area of 331,688 km2 south. It has an S-shaped landform with a distance of 1,650 km from north to south, but is only 50 km wide at its narrowest point from east to west. It has a very narrow topography, which has a great impact on the performance of the computer. Assuming a saturation nuclear strike on Vietnam using Tsarist bombs, a total of 25 Tsarist bombs are required, considering the previously established model, and using Matlab to write a good program with a map of Vietnam as input, the output is shown in Figure 13(b).

In this paper, in order to get better data on the Earth’s surface and to ”destroy the Earth”, and to determine which places do not need nuclear strikes (such as permafrost, deserts, barren lands, etc., which are basically uninhabited by any living creatures and do not need nuclear strikes), we refer to NASA’s MODIS data, Land This paper uses MATLAB to import the 3600×7200 global pixel data into MAtlab, as shown in Figure 14.

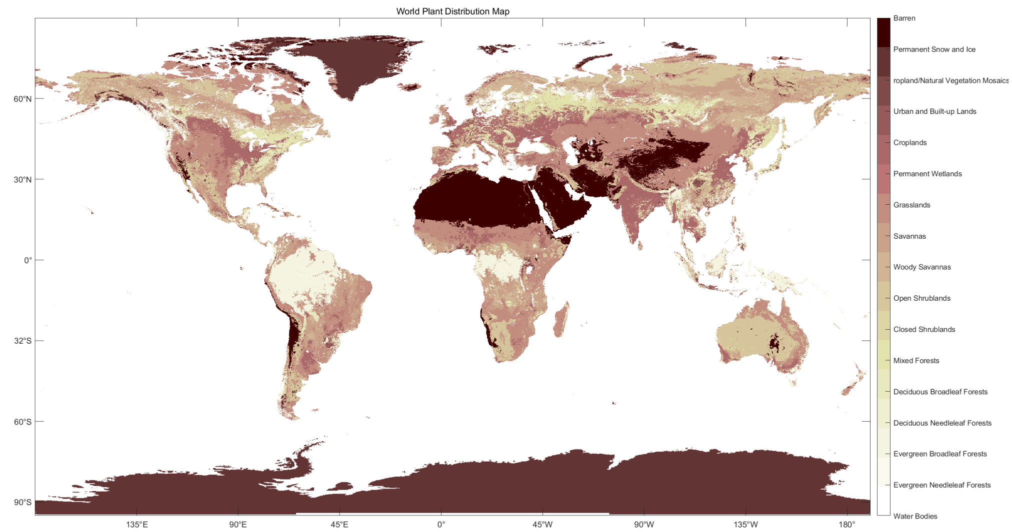

Figure 14 NASA's Land Cover Vegetation Infographic

Then the land types that do not need nuclear strikes are selected, and each pixel point is classified using Matlab and a new picture is obtained again, and the picture marked as needing nuclear strikes is the area that needs nuclear strikes totaling $0.9759 \times 10^8 KM^2$.

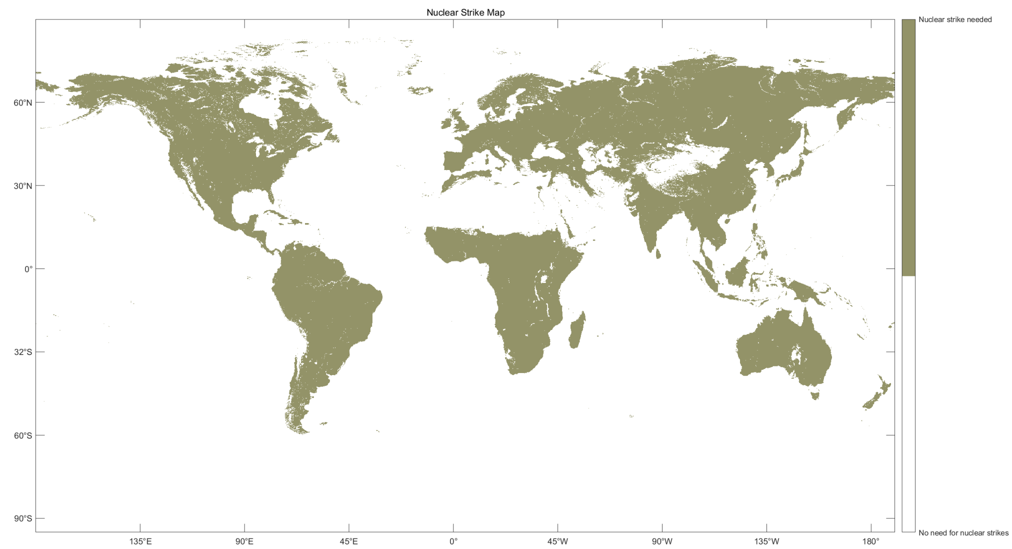

Figure 15 Areas requiring nuclear strikes

Similarly, using the above-mentioned location-determining model in the picture 15, the result is that at least 3689 tsarist bombs or 22,134∼29,512 annexed nuclear bombs are needed to destroy the Earth.

b) According to the mathematical model, what is the maximum destructive power of the nuclear bomb currently possessed? Is it enough to destroy the earth?

By 2022, the number of all nuclear bombs in the world is 9440 approximately equal to the power of 1,180∼ 1,573 tsarist bombs, which is not enough to destroy the earth, but will cause 20%∼ 28% of the world's land to be destroyed, and if all these bombs explode in dense urban areas, it will cause 8,277,711,800∼ 11,034,610,730 direct deaths and 8,113,845,200∼ 10,816,168,220 direct injuries, the land could not be reused for several years, and these nuclear pollutants would spread to the world with the atmosphere and water circulation, which would cost the world a lot.

c) In order to protect the earth and the environment on which we live, what should the total number of nuclear bombs in the world be limited to, and what should the countries that already have nuclear weapons be limited to theoretically?

It is more appropriate to control the number of nuclear bombs to the amount that affects 2% of the world's land, which is about 118 tsar bombs and 708∼ 944 nukes in the annex, so that the world can be safe and the world will not be destroyed. Our team allocated proportionally to the number of individual countries with nuclear bombs in 2022 and finally obtained the following table 5 allocation scheme.

Table 5 Distribution scheme after limiting the number of nuclear bombs

Country	China	France	India	Israel	North Korea
num	26∼ 35	22∼ 29	12∼ 16	7∼ 9	2
Country	Pakistan	Russia	United Kingdom	United States	
num	12∼ 17	336∼ 448	14∼ 18	278∼ 371	

VII. Some recommendations for the United Nations

The history of nuclear weapons development in the world determines the future of nuclear weapons development. Comparing the results of nuclear weapons development scenarios, we can see the inner laws of nuclear weapons development. With the current total number of nuclear weapons worldwide not enough to destroy the planet, but with irreversible consequences for the planet and with more and more countries choosing to develop nuclear weapons as the last line of defense for their nations, the following are some of our team's recommendations in the face of the increasingly serious nuclear weapons challenge:

- ★ **First, the nuclear threshold should be raised to restrict the export of nuclear materials and prevent more and more countries from possessing nuclear weapons.**After our team's research, we found that as time went on, more and more countries started to develop nuclear weapons for their independence and autonomy, which undoubtedly added to the already proliferation of nuclear weapons.
- ★ **Second, reduce the gap in the number of nuclear weapons between the nuclear powers to avoid one side becoming too powerful.**If the difference in the number of nuclear weapons exceeds a certain order of magnitude will make other countries for the absolute number of countries to lose the right to speak, in fact, it is not difficult to find that a few hundred rounds of nuclear weapons alone can not destroy a large number of countries, to avoid the absolute advantage of some countries for other countries, we must strictly control the gap between the nuclear powers nuclear weapons to avoid some countries to use nuclear blackmail to create pressure on other countries and arbitrarily manipulate their own hegemony.
- ★ **Third, advocate peaceful development and try to "denuclearize" the world**The power of nuclear weapons is still very alarming. In order to avoid some accidental mistakes or political

conflicts that produce irreversible damage to the earth, it is recommended that the world be slowly denuclearized and peaceful development is beneficial to all countries, so that the world can develop in harmony and stability.

In conclusion, the future challenge of nuclear weapons in the world is still very serious, and one of the most important strategic initiatives is to coordinate with nuclear-armed states to resolve both near-term and long-term conflicts. The nuclear weapons issue cannot be solved by short-term measures, and therefore, the key to solving the nuclear weapons issue is to constantly adjust the strategy to the international situation.

VIII. OUR ARTICLE

Since August 6, 1945, the United States dropped an atomic bomb called ”Little Boy” on Hiroshima, Japan, which killed 200,000 people and collapsed all the buildings in Hiroshima. The atomic bomb is a kind of nuclear weapon, and many people realized the terrible power of the atomic bomb for the first time. Nuclear weapons are weapons of great lethality associated with nuclear reactions, including hydrogen bombs, atomic bombs, neutron bombs, etc. Nuclear weapons are among the most powerful weapons ever developed by mankind and often remind people of the destruction of the earth and the sky. The instantaneous explosion temperature of an atomic bomb can reach tens of millions of degrees. The explosive yield of the atomic bomb is about tens of thousands to hundreds of thousands of tons of TNT equivalent. The explosion of an atomic bomb and its radiation range can destroy a city. But are nuclear weapons powerful enough to exterminate the human race?

It is because of the terrible power of nuclear weapons, each country in order to ensure their own security or to deter other countries, have opened nuclear weapons research, and some countries have even built ”big Ivan” and other weapons of great destructive power. So many people think that these nuclear weapons are enough to destroy the earth, or even to blow the earth into pieces, so that the human race extinct, etc., but is this really the case?

Our team did a research analysis of this series based on current global nuclear weapons related data, national strategies, economics, international environment and arms control and other influencing factors. We found that there are a total of ten countries that have ever possessed nuclear weapons globally and a total of nine countries that currently possess nuclear weapons. With the end of the world wars, the stockpiles of nuclear weapons have been reduced, with the United States being the country that has reduced its stockpile the most. Over the past few decades, the most nuclear weapons tests worldwide were conducted between 1962 and 1966, with 422 nuclear weapons tests. The United States has taken the shortest time of any country in the world to move from ”not considering nuclear weapons” to ”possessing nuclear weapons” in just seven years. ”.

The BP neural network model about the number of nuclear weapons is built directly for 9 countries with nuclear weapons. For other countries, relevant data are collected to form four indicators: GDP, per capita GDP, military expenditure as a percentage of GDP and absolute military expenditure, and these four indicators are input as neural networks to make predictions. After solving the model, nine countries including China and France will possess nuclear weapons in the next 100 years. As for the number of nuclear weapons in the next 100 years, the neural network model is also used to solve the problem, and it is concluded that the number of nuclear weapons in the world will decline slowly in the next 100 years, reaching 7,830 in 2123. The number of nuclear weapons in 2123 by the nine nuclear-armed states: 361 for China and 3,803 for the United States, as shown in Table 4. In all but nine countries, it was 0.

we first solve the explosion location of nuclear weapons through a multi-objective optimization model, and then optimize it through particle swarm algorithm to get the optimal solution, taking Vietnam as an example, using the model to cover the entire territory of Vietnam requires 25 tsarist bombs and has nuclear weapon detonation coordinates. This paper concludes that 3689 Tsarist bombs are needed to destroy the Earth, and the global nuclear bombs cannot destroy the Earth combined, but they can also cause a lot of damage, and finally this paper considers that the total number of nuclear bombs is controlled at 708∼ 944 bombs is more stable, and proposes an allocation scheme as shown in Table5.

Finally, we suggest that all countries should be cautious about the development and testing of nuclear weapons, and be particularly careful about their application. To damage the ecological environment is actually to harm themselves. We should start from a harmonious and beautiful foundation and build a better future.

IX. Conclusions

9.1 Conclusions of the problem

- China, France, India, Israel, North Korea, Pakistan, Russia, South Africa, the United Kingdom, and the United States are among the countries that have had nuclear weapons; the United States has had the largest reduction in its nuclear weapons stockpile in the last two decades; the largest number of nuclear weapons tests in 1962-1966, 422; North Korea has been the most active in nuclear weapons research in the last decade; and the United States has made the transition from ”not considering nuclear weapons” to ”having nuclear weapons. The United States has seen the largest reduction in its nuclear weapons stockpile over the past two decades; the largest number of nuclear weapons tests in 1962-1966 was 422; North Korea has been the most active in nuclear weapons research over the past decade; and the United States has made the fastest transition from ”not considering nuclear weapons” to ”possessing nuclear weapons.
- Nine countries, including China and France, will have nuclear weapons within 100 years. The number of nuclear weapons in the next 100 years is solved by neural network model.
- In order to destroy the Earth (in this article, the destruction of all living things on the surface and the destruction of the ecosystem is considered as the destruction of the Earth), 3689 tsar bombs or 22,134∼ 29,512 annexed nuclear bombs would be needed to destroy the Earth. Currently all nuclear bombs in the world are not enough to destroy the Earth, but they would destroy 20%∼ 28% of the world’s land, and if all these bombs exploded in dense urban areas, they would cause 8,277,711,800-11,034,610,730 direct deaths, 8,113,845,200-10, 816,168,220 direct injuries, land that could not be reused for years, and nuclear contaminants that would spread around the world in the atmosphere and water cycle, at a huge cost to the world. It would be more appropriate to limit the number of nuclear bombs to the number affecting 2% of the world’s land, about 118 tsar bombs, 708∼ 944 nukes in the annex, so that the world would be safe and the world would not be destroyed.

9 . 2 Methods used in our models

- Mathematical Statistics
- BP Neural Network Fitting
- Time Series Forecasting
- Particle swarm algorithm

9 . 3 Applications of our models

- Forecasting the country's future GDP, absolute military spending, and military spending as a ratio of GDP
- It is possible to calculate the power of a nuclear bomb more accurately, using a simple mathematical-physical model and using statistical knowledge to make the model as simple as possible without losing accuracy.

X. Future Work

10 . 1 Another model

When predicting time series, we use Neural Net Time Series to build a model for time series data and predict future data based on the model. The data predicted by this model is compared with the data predicted by us to analyze the differences that exist in each data and to determine the strengths and weaknesses of the model.

10 . 1 . 1 *The limitations of prediction model*

The prediction model has a very obvious disadvantage that it only guarantees better prediction accuracy in the short term. The question asks to predict the data for the next 100 years, while the available data is only about seventy years.

10 . 1 . 2 *Limitations of mathematical physical models*

The mathematical physics model can consider several aspects to make the model more comprehensive and perfect, and further promote to get a more perfect model.

XI. References

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XII. Appendix

Years	Times		Years	Times
1945-1949	7		1981-1985	247
1946-1950	6		1982-1986	220
1947-1951	22		1983-1987	218
1948-1952	33		1984-1988	203
1949-1953	48		1985-1989	174
1950-1954	63		1986-1990	156
1951-1955	87		1987-1991	147
1952-1956	102		1988-1992	108
1953-1957	146		1989-1993	69
1954-1958	244		1990-1994	43
1955-1959	228		1991-1995	32
1956-1960	207		1992-1996	21
1957-1961	245		1993-1997	13
1958-1962	368		1994-1998	16
1959-1963	302		1995-1999	14
1960-1964	362		1996-2000	7
1961-1965	417		1997-2001	4
1962-1966	422		1998-2002	4
1963-1967	308		1999-2003	0
1964-1968	337		2000-2004	0
1965-1969	344		2001-2005	0
1966-1970	350		2002-2006	1
1967-1971	327		2003-2007	1
1968-1972	320		2004-2008	1
1969-1973	289		2005-2009	2
1970-1974	277		2006-2010	5
1971-1975	257		2007-2011	4
1972-1976	255		2008-2012	4
1973-1977	252		2009-2013	5
1974-1978	270		2010-2014	4
1975-1979	273		2011-2015	1
1976-1980	283		2012-2016	3
1977-1981	282		2013-2017	4
1978-1982	277		2014-2018	3
1979-1983	266		2015-2019	3
1980-1984	265			

Figure 16 Number of trials in five years

Listing 1: First question matlab code

```
load('ten.mat');
plot(ten(:,1),ten(:,2),'-ro',ten(:,1),ten(:,3),'-go',ten(:,1),ten(:,4),'-bo',...
    ten(:,1),ten(:,5),'-co',ten(:,1),ten(:,6),'-mo',ten(:,1),ten(:,7),'-o',...
    ten(:,1),ten(:,8),'-ko',ten(:,1),ten(:,9),'-o',ten(:,1),ten(:,10),'-o',...
    ten(:,1),ten(:,11),'-o');
xlabel('Year');ylabel('nuclear weapons stockpiles');
legend('China','France','India','Israel','North Korea','Pakistan','Russia','South
    Africa','Untied Kingdom','United States');

%1-c
load('tests.mat');
sum=0;
fiveyears=zeros(71,1);
for i=1:71
   for j=i:i+4
      sum=sum+tests(j);
   end
   fiveyears(i)=sum;
   sum=0;
end
figure(2)
year=[1945:1:2015]';
plot(year,fiveyears);
xlabel('year');ylabel('Number of nuclear weapon tests in five years');
[m,ind]=max(fiveyears);
ind=ind+1944;
fprintf("年份:%0.f-%0.f\n:%0.f\n",ind,ind+4,m);
```

Listing 2: Second question matlab code

```
load('CountryHwqNum.mat');
load('net1.mat');load('net2.mat');load('net3.mat');load('net4.mat');
load('net5.mat');load('net6.mat');load('net7.mat');load('net8.mat');
load('net9.mat');
y=zeros(78,9);
x=CountryHwqNum.year;
figure(2)
year=1945:2123;
for j=1:9
   pre_y = zeros(179,1); % predict_y
   if j==1
      a=net1; b='China';
   elseif j==2
      a=net2; b='France';
   elseif j==3
      a=net3; b='India';
   elseif j==4
      a=net4; b='Israel';
```

```
    elseif j==5
        a=net5; b='NorthKorea';
    elseif j==6
        a=net6; b='Pakistan';
    elseif j==7
        a=net7; b='Russia';
    elseif j==8
        a=net8; b='UnitedKingdom';
    elseif j==9
        a=net9; b='UnitedStates';
    end
    for i = 1:179
        result = sim(a, year(i));
        pre_y(i) = result;
    end
    y(:,j)=table2array(CountryHwqNum(:,j+1));
    subplot(3,3,j);plot(x,y(:,j),'o');hold on
    plot(year(1:78),pre_y(1:78),'-',year(78:179),pre_y(78:179),'--','LineWidth',1.2);
    legend('true value','fitted vingue','predicted
         value');xlabel('year');ylabel('stockpiles');
    title(b);
end
```

Listing 3: Third question matlab code

```
%land=shaperead('landareas.shp','UseGeoCoords',true);
%geoshow(land,'FaceColor',[0.5 0.7 0.5])

%lakes=shaperead('worldlakes.shp','UseGeoCoords',true);
%geoshow(lakes,'FaceColor','blue')

%rivers=shaperead('worldrivers.shp','UseGeoCoords',true);
%geoshow(rivers, 'Color', 'blue')

%cities=shaperead('worldcities.shp','UseGeoCoords',true);
%geoshow(cities,'Marker','.','Color','red')

FILE_NAME = 'MCD12C1.A2020001.006.2021362215328.hdf';
data = hdfread(FILE_NAME,'Majority_Land_Cover_Type_1');
figure(1)
imagesc(data,[0,16]);
colormap(flipud(pink(17)))
colorbar('Ticks',[0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16],...
        'TickLabels',{'Water Bodies','Evergreen Needleleaf Forests',...
        'Evergreen Broadleaf Forests','Deciduous Needleleaf Forests',...
        'Deciduous Broadleaf Forests','Mixed Forests','Closed Shrublands',...
        'Open Shrublands','Woody Savannas','Savannas', 'Grasslands',...
        'Permanent Wetlands','Croplands','Urban and Built-up Lands',...
```

```
        'ropland/Natural Vegetation Mosaics','Permanent Snow and Ice',...
        'Barren'})
xticks([0 875 1750 2625 3500 4375 5250 6125 7000])
xticklabels({'180°','135°E','90°E','45°E','0°','45°W','90°W','135°W','180°'})
yticks([0 583 1167 1750 2333 2917 3500])
yticklabels({'90°N','60°N','30°N','0°','32°S','60°S','90°S'})
title('World Plant Distribution Map')

figure(2)
sum=0;
data1=data;
for i=1:1:3600
for j=1:1:7200
if(data1(i,j)==16||data1(i,j)==15||data1(i,j)==0)
   data1(i,j)=0;
else
   data1(i,j)=1;
   sum=sum+1;
end
end
end

imagesc(data1,[0,1]);

colormap(flipud(pink(2)))
colorbar('Ticks',[0,1],...
        'TickLabels',{'No need for nuclear strikes','Nuclear strike needed'})
xticks([0 875 1750 2625 3500 4375 5250 6125 7000])
xticklabels({'180°','135°E','90°E','45°E','0°','45°W','90°W','135°W','180°'})
yticks([0 583 1167 1750 2333 2917 3500])
yticklabels({'90°N','60°N','30°N','0°','32°S','60°S','90°S'})
title('Nuclear Strike Map')
```