ISSN: 2414-1895 DOI: 10.6919/ICJE.202012_6(12).0062

Computer Software and Hardware Fault Diagnosis Method Based on SVM

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Abstract

With the rapid development of information technology and the popularity of the Internet in the world, the status of computer in daily life and work is becoming more and more important. However, as a highly integrated electronic information equipment, the computer has high precision, and the probability of failure is very high. When there is a problem, the general staff can handle it, but it is difficult to repair because of the lack of computer knowledge. Based on the above background, the purpose of this paper is to discuss the fault diagnosis method of computer software and hardware based on SVM. In view of the shortcomings of artificial diagnosis method of laboratory computer hardware fault, such as strong subjective factors, large error and high failure rate, a fault diagnosis method based on SVM algorithm is proposed. In this paper, SVM algorithm and maximum likelihood estimation algorithm are used to analyze the construction of fault diagnosis model in detail. Taking one or more hardware failures in the process of computer operation as an example, the SVM algorithm diagnosis reasoning is carried out. The effectiveness of the method is verified by comparing the simulation results. The results show that compared with the artificial fault diagnosis method, the efficiency of SVM algorithm is improved by about 20%, so the prediction method of SVM algorithm plays a certain role in reducing the failure rate of computer software and hardware, and it is feasible.

Keywords

SVM Algorithm, Computer Failure, Fault Diagnosis, Diagnosis Prediction rate.

1. Introduction

The emergence of computers has enabled human society to achieve technological breakthroughs, and science and technology have begun to develop rapidly. It is the creative invention of human beings [1-2]. From the original bulky and slow electronic tube era, it gradually moved to small size and high performance. The development of the era of fast VLSI and digital circuits highlights the performance characteristics of intelligent and miniaturized network multimedia [3]. However, the development of everything has both advantages and disadvantages [4]. No matter how advanced the equipment is and how mature the science and technology is, failures are inevitable. After all, all current equipment is composed of electronic components, and it is impossible to guarantee that any electronic component will not fail, and computers are no exception.[5]

Computers make people's lives more comfortable and work more convenient and efficient, but it also inevitably brings some negative problems-people's excessive dependence on computers, which makes people do not know how to work or even live once the computer fails.[6]. Compared with foreign countries, the computer industry in my country started late, and there are still differences between computer technology and the international [7-8]. With the increasing popularity of computer

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applications, the phenomenon of failures during computer operation has also increased. Once a failure occurs, the computer will not operate normally, affecting life is small, endangering safety or even causing accidents [9]. Under normal circumstances, users have no way to distinguish the cause of network failures, or even can't tell whether it is a hardware failure or a software failure. Most users will restart the computer to eliminate the failure, but this operation cannot be solved in essence. Question [10]. Therefore, how to reduce failures, ensure the normal operation of computers, and reduce the economic losses caused by downtime is an urgent problem that needs to be solved.

Based on the computer laboratory of universities and the daily maintenance data of the computer laboratory, this article is committed to the use of SVM to realize the research of computer hardware fault diagnosis, so as to improve the efficiency of fault diagnosis, shorten the downtime, extend the service life of the equipment, and reduce The labor intensity of maintenance personnel and the reduction of economic losses caused by failures.

2. Computer Failure and SVM Algorithm

2.1 Support Vector Machine

Support vector machine (SVM) is a binary classification model, which is mainly used for pattern recognition, classification and regression analysis. Its basic principle is to find a maximum classification interval in the sample space. It transforms the problem into a convex quadratic programming problem by setting the goal to maximize the interval between two types of samples. Support vector machine is a supervised learning model, that is, every sample must have its classification label. In essence, it is a linear classifier problem, which extends from linear separable to linear nonseparable.

If there is a set of sample sets, the samples in the sample set can be divided into two categories. If x is the data point and Y is the category (y can be taken as 1 or - 1, where 1 and - 1 have no numerical significance, they are only used to identify two different classes). The support vector machine is to find a hyperplane in this n-dimensional data space. The equation of the classification hyperplane can be expressed as follows:

$$\omega^T x + b = 0 \tag{1}$$

For the linear indivisible problem, we can add a relaxation factor $\xi_i \geq 0$ to the Lagrangian extremum problem, which can be changed into:

$$y_i[(\omega \cdot x_i) + b] + \xi_i \geq 1 \tag{2}$$

Change the minimization $\frac{1}{2}\|\omega^2\|$ to the minimization $\frac{1}{2}\|\omega^2\| + C\left(\sum_{i=1}^{1} \xi_i\right)$, that is, comprehensively consider the least misclassified samples and the maximum geometric interval to obtain the optimal classification surface.

However, in many classification problems, the sample data is linearly inseparable. When dealing with linearly inseparable problems, the kernel function is generally used to map the linearly inseparable sample data in the low-dimensional space to the high-dimensional space to make it in the high-dimensional space. The median linear separable, and then find the optimal classification plane in this space. The function that calculates the inner product of two vectors in the mapped high-dimensional space is called Kernel Function. At present, there are many types of kernel functions, and the more commonly used ones include: Gaussian kernel function $k(x_1, x_2) = \exp\left(-\frac{\|x_1 - x_2\|^2}{2\delta^2}\right)$, linear kernel function $k(x, y) = \langle x_1, x_2 \rangle$, and polynomial kernel Function $K(x_1, x_2) = (x_1 \cdot x_2 + 1)^{\wedge} d$.

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2.2 Fault Characteristics of Computer Network Software and Hardware

Generally speaking, faults can be divided into two types: the first is physical fault, also known as hardware failure, and the second is logical fault, also known as software fault. The relationship between most symptoms and faults is complex, so there are many difficulties in the maintenance process. The following are the main features of the fault.

(1) Hierarchy. This feature belongs to the "longitudinal" of the fault. In the division of computer network structure, its level mainly includes modules, subsystems, components and systems, etc. from the perspective of function, it can be divided into several layers, so symptoms and faults are likely not in the same level. All faults are closely related to one layer. However, the high-level faults mainly originate from the low-level faults, which will inevitably affect the high-level faults.

(2) Correlation. This feature belongs to the "transversality" of the fault and depends on the relationship between all elements of the system. If one of the factors fails, the related elements will also fail in a short time. The relationship between fault and symptom is more complex, which increases the difficulty of fault diagnosis. According to the correlation of faults, the causes of many faults can be attributed to one, so as to simplify the problems.

Uncertainty. This feature belongs to the "fuzziness" of fault. Because of the fuzziness and randomness of symptoms and fault information, there is uncertainty between them. The characteristics of the elements corresponding to each level and the relationship between elements of the same system in different operating environments and time are uncertain, so it is difficult to determine the law, so there is no way to determine the specific cause of the fault

3. Computer Fault Diagnosis Experiment

3.1 Collect Data to Determine Variables

First, data collection. The data in this paper mainly come from the computer labs with thousands of scale. The maintenance data is large, easy to collect and representative. Due to the large number of records which can not be listed one by one, only representative faults are selected. Some maintenance records are shown in Table 1. According to the actual investigation, combined with the knowledge of domain experts and the working experience of professional and technical maintenance personnel, the maintenance data of the laboratory from two years to the first semester (September to January of the next year) and the next semester (March July) are collected for statistics.

Table 1. Computer failure maintenance record table

Serial number	Device ID	Fault conditions	Cause of issue	Treatment measures	Process result
1	20140223	System unavailable	Student U disk brought virus	Antivirus	Carry out
2	Multiple devices	The BIOS is attacked by a virus and the system cannot be started	Virus attack	Restore BIOS settings	Carry out
3	20140211	The machine starts to sound an alarm	Memory gold finger oxidation	Deoxidation treatment	Carry out
4	20140862	The machine starts to sound an alarm	The brightness adjustment module is damaged	Replace the display	Carry out
5	20140821	Computer restarts repeatedly	Insufficient power supply voltage	Replace the power supply	Carry out
6	20140237	Computer alarm	CUP fan is blocked by dust	Dust removal of the whole machine	Carry out

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3.2 Overall System Design

The system is divided into three modules: database module, condition monitoring module, fault diagnosis and prediction module.

(1) Database module, also known as knowledge module, is mainly used to collect, screen and establish sample database. Through consulting professional books and literature, the knowledge summarized by experts is classified; on-site investigation, communication with professional technicians engaged in maintenance for many years is conducted to obtain experience and lessons; maintenance data records over the years are collected, incomplete and extreme data are eliminated, and a certain representative effective data is retained, and then combined with expert knowledge and prior experience, the data is quantified, Establish as complete a database as possible. In addition, in order to ensure the accuracy, diversity and integrity of the data in the database, it is necessary to constantly update it, and constantly add new knowledge, experience and data from diagnosis cases to the old database.

(2) The state monitoring module includes condition monitoring and data extraction, mainly for the equipment to be detected for status signal monitoring and feature extraction. According to the actual operation of the equipment itself, combined with the purpose and object of diagnosis, the most convenient signal which can reflect the running state of the equipment is selected for monitoring. In order to improve the efficiency and find the fault phenomenon as soon as possible, on the one hand, the data monitoring of the system can monitor the display status of the display in real time through the monitoring in the laboratory. The image cutting processing is carried out for the blue screen, crash, computer start-up self-test error and screen printing, According to certain rules, quantitative coding and feature value extraction are carried out, and then compared with the data in the database to judge whether it is normal or not, and then carry out the next step of diagnosis and prediction; on the other hand, the data monitoring can be collected by corresponding sensors and manual data records.

(3) After all the preparatory work has been completed, the following is the most critical part of the whole system diagnosis and prediction. It is combined with computer fault, and the equipment is judged to be normal after data comparison and analysis. If it is normal, continue to monitor; if abnormal, further data analysis to determine whether the fault has occurred or is about to occur. For the faults that have occurred, the decision processing is made immediately and the user is informed to remove the faults; for the faults that are about to occur, the forecast warning is issued and the prediction results are fed back to the users. Finally, the accuracy of computer software and hardware in fault diagnosis and prediction can be improved.

4. SVM Algorithm Computer Fault Diagnosis Analysis

4.1 Prediction Results and Analysis

Firstly, a group of observation data $t = T_1$, w = W1 is selected from 100 groups of test data, and the posterior probabilities of $D_1 = 0$ and $D_1 = 1$ under given data conditions are calculated and compared, so as to predict whether node D_1 will fail in the current state of observation data, and because the occurrence of fault has randomness, 0.5 is determined as a probability threshold of whether the fault occurs. If $P(D_1 = 1) \geq P(D_1 = 0) = 0.5$, it is considered that the computer will crash under the current observation data state; if $P(D_1 = 0) > P(D_1 = 0) = 0.5$, the computer will not crash under the current observation data, and so on, 2D, 3D... Until all 100 groups of test data get the prediction results. The probability curve of simulation results is shown in Figure 1.

As can be seen from Figure 1, the abscissa represents the selected sample size, the ordinate represents the predicted posterior probability value, the circle represents the probability of computer crash, and the asterisk represents the probability that the computer crash does not occur. For each group of data samples, the posterior probability is calculated to determine whether the failure occurs. The higher probability is located at the top of the graph, that is, when 10d & D, the computer crash fault occurs. Through comparison, it can be seen that 71 groups of data prediction computer will crash, and 29 groups of data will not.

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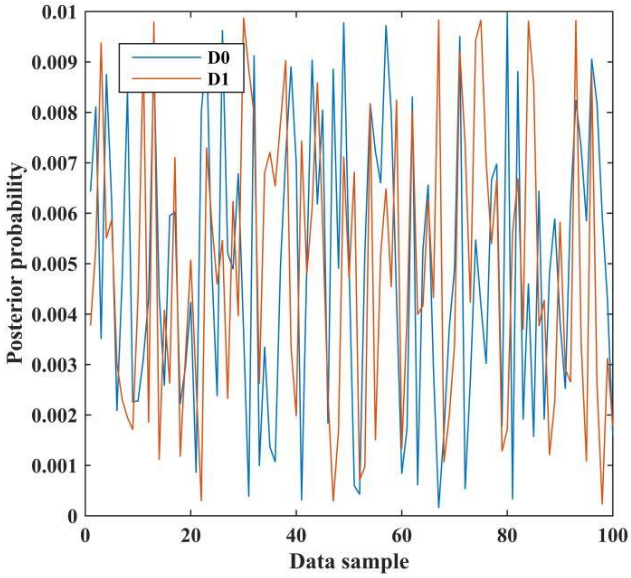

Figure 1. Forecast posterior probability curve

4.2 SVM Reasoning Analysis of Fault Prediction

With the increase of the sample size, the prediction accuracy first shows an upward trend, and then gradually stable, which also verifies that the SVM network method will increase the accuracy with the increase of data. Finally, when the data reaches a certain capacity, the prediction accuracy is basically maintained at about 71%, and there is a certain deviation compared with the historical data. The prediction result is not very ideal, and the predicted goal of 85% is not achieved. The computer failure rate comparison of the two methods before and after the improvement is shown in Figure 2.

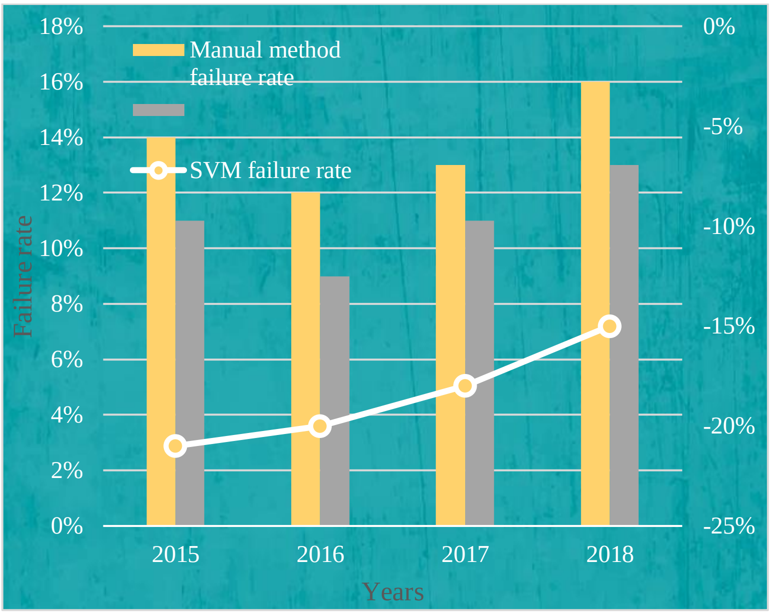

Figure 2. Comparison of failure rate before and after improvement

As can be seen from Figure 2, when the SVM prediction method is applied to the data over the years, the failure rate once reaches about 10% when the number of computers is small, and the effect is very ideal. However, with the increase of the number of computers, the failure rate also increases. When the number of computers in the laboratory is saturated, the corresponding failure rate predicted by

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SVM network is only about 18%, which does not reach the expected target of 21%. This can be seen from the year-on-year growth rate. According to the expected target, the year-on-year growth rate as a whole should show a downward trend, but the simulation results are just the opposite; from the aspect of month on month, the artificial method shows an overall upward trend with the increase of the number of computers, which is in line with the actual situation, while the SVM prediction method makes the failure rate decrease, but the growth rate of the month on month is a gentle upward trend, which does not achieve the expected effect. The conditional probability distribution of each node after learning is shown in Table 2.

Table 2. Conditional probability table of the motherboard after learning

Temperature	Humidity	Hard disk	
		False	True
False	False	0.8824	0.1176
True	False	0.1667	0.8333
False	True	0.3488	0.6512
True	True	0.1834	0.8166

The main reason is that the prediction model is too simple, the selection of variables is too few, and the data acquisition is limited, which leads to the deviation in SVM learning stage. In addition, the computer crash is the result of many factors. However, some data acquisition difficulties, such as electromagnetic, electric voltage, dust, static electricity, etc., eventually make the accuracy of fault prediction not high, and then affect the failure rate, But generally speaking, the prediction model is still effective.

5. Conclusion

In a word, it is very necessary to be able to repair the computer hardware and software faults and understand the daily maintenance work of the computer. But the computer fault processing is a complex and requires a lot of experience. Understanding the above methods is conducive to our daily work, creating a good environment for our work and improving our work efficiency.

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