



BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(17), 2014 [9487-9494]

Application of ancient Chinese thought of yin and yang to computer education

Jiang Fangchun*, Lu Yunfan

Shen Zhen Institute of Information Technology, No.2188 Longxiang Blvd, Shenzhen, (CHINA)

ABSTRACT

The yin and yang theory is a simple dialectical materialist philosophy originated in ancient China. This study applied the ancient Chinese thinking of yin and yang to computer education, and performed applied research in software testing. The concepts of yin and yang tests, and three basic principles, inherence, mutual inclusion, and transformation of yin and yang tests, were proposed. Finally, a comparative experiment was conducted and favorable results obtained.

© 2014 Trade Science Inc. - INDIA

KEYWORDS

Yin test;
Yang test;
Yin and yang theory;
Software testing;
Computer education.

INTRODUCTION

In modern times, philosophy has undergone tremendous changes. Scientific revolution has led to separation of natural science from philosophy. Other disciplines, such as sociology, logic, ethics, and psychology, also separated from philosophy and became independent. Finally, philosophy has become a specific discipline for people to explore the most fundamental and universal law of the world^[1].

Sinology refers to the traditional Chinese culture and academic study based on Confucianism. The philosophy of Sinology includes a theory called the yin and yang theory, which is the simple ancient Chinese philosophy of dialectical materialism.

The American scholar engaged in the research of Chinese history of science, R.A. Yurrit^[2], said: "Modern ideology is not the private product or wealth of the west. It not only belongs to Aristotle, Euclid, Copernicus, or Newton, but also is contrib-

uted by Chinese scholars Lao-Tse, Tsou Yen, Shen Kuo, and Chu His. The understanding of the world as a unified whole in today's scientific development is not unrelated to Chinese traditional science. The goal of Chinese natural philosophy and science has been to understand the unified, natural, orderly, interrelated, coordinated, and interconnected structure of the universe".

This study applied the ancient Chinese traditional thought of yin and yang to computer education, described software testing, and performed applied research in software testing.

BASIC CONTENT OF YIN AND YANG THEORY

The generation and content of the yin and yang theory and the relationship between yin and yang are discussed below.

Generation of yin and yang theory

FULL PAPER

The ancient meaning of yin “YIN” and yang “YANG” is shady side and sunny side, respectively, and has no philosophical connotation. The concept of yin and yang originated from ancient observation of natural phenomena, and was produced around the late primitive society. People began to develop the concept of yin and yang based on the presence and absence of sufficient sunlight when they stood on the hill and saw the obvious difference between the sunny south side of the hill with lush plant growth, and the cold dark north side with depressed plant growth. The concept of yin and yang was specific and physical at that time. Over time, people found more and more opposite or contrary forces are actually complementary, interconnected and interdependent in the natural world, and thereby developed the bipolar thinking and binary classification system, which is the yin and yang theory. The concept of yin and yang thus turned from a concrete description to an abstract concept for explaining the development and changes of everything in the world^[3].

This abstract concept of yin and yang has become the ideological backbone of Chinese traditional culture, and determines the thought pattern of Chinese people. This worldview affects all aspects of the Chinese nation. In natural sciences, the yin and yang theory has been applied to astronomy and geography to explain how the seasons change and how everything rises and falls. Similarly, in software testing, the yin and yang theory can be applied to research on the selection of software testing methods and models and the balancing of testing workload, thus enriching and developing the software testing theory.

Content of yin and yang theory

The so-called yin and yang are the comprehension of two opposite forces that are actually interconnected in the natural world. It is an abstract concept rather than specific things.

Because yin and yang are the comprehension of two opposite forces, it can represent not only the unity of two inherent opposite attributes, but also the two opposite sides within the same component. Therefore, everything contains both the yin and yang opposites, and each of the opposites includes an-

other pair of yin and yang respectively.

Whether one thing is yin or yang is determined by its nature, trends, location, and other attributes. Generally speaking, anything active, overt, progressive, ascending, hyperactive, or functional is considered yang; and the opposite side, i.e., anything inactive, covert, retrogressive, descending, hypoactive, or organic belongs to yin. In terms of movement and changes of things, the static is yin and the dynamic is yang, and the dark is yin and the bright is yang. Things are yin when in a quiet state and yang when in an active state.

The basic content of the yin and yang theory is the opposition and restriction, mutual rooting, waxing and waning, and transformation between yin and yang^[4].

According to the basic theory of yin and yang, in terms of software testing theory and techniques, static testing is yin, and dynamic testing is yang; black-box testing is yin, and white-box testing is yang; performance testing is yin, and functional test is yang.

Relationship between yin and yang

The yin and yang theory, like the law of the unity of opposites, recognizes that things have two aspects that are interdependent and can be mutually transformed. In the yin-yang symbol of the yin and yang theory, a blank sheet is called Wu Chi (literally “no extremity”), drawing a circle on the blank sheet is called “Wu Chi generates Tai Chi (literally “great or supreme ultimate”)”, and the circle being divided into a black and a white segment by an S-shaped line is called “Tai Chi generates two complementary forces.” The line in the middle of the yin-yang symbol represents the mutual movement and transformation between yin and yang. The inclusion of a small circle in the opposite color in the black and white hemispheres, respectively, indicates that there is always yin in yang and yang in yin Figure 1. This

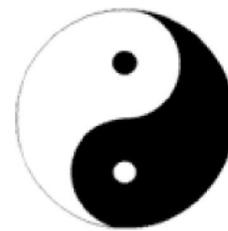


Figure 1 : Tai chi diagram

symbol is a simple and complete presentation of the basic idea of yin and yang theory, and has played a very important role in popularizing the yin and yang theory.

The opposition and restriction between yin and yang means all things or phenomena in the world have the yin and yang opposites, such as top and bottom, heaven and earth, dynamic and static, and up and down; the top is yang and the bottom is yin, the heaven is yang and the earth is yin, the dynamic is yang and the static is yin, and the up is yang and the down is yin. Yin and yang exist in relation to each other in a single unity, mutually restricting and conflicting.

The mutual rooting of yin and yang means yin and yang are two opposing aspects that are actually and rooted in and interdependent on each other. None of them can exist without the other. The top is yang, the bottom is yin, and there is no bottom without a top; hot is yang, cold is yin, and there is no hot without cold. Yin depends on yang and yang depends on yin. Each is the existence condition of the other. This interdependence is also known as “mutual rooting.”

The opposition and interdependence between yin and yang is not changeless or static, but always in a process of waxing and waning. Yin and yang achieve a dynamic balance in waxing and waning. The waxing and waning is absolute, and dynamic balance is relative. This is the balance in waxing and waning of yin and yang.

The waxing and waning and transformation between yin and yang are often in a relatively balanced state. If the waxing and waning goes beyond a certain limit, and can not maintain a relative balance, the excessiveness or deficiency of yin or yang, i.e., a substantial change, will occur. The yin and yang aspects of things, when get to a certain level, can be transformed into the opposite, that is, yang can be transformed into yin, and yin can be converted to yang. If the waxing and waning of yin and yang is a quantitative change, then the transformation between yin and yang is a qualitative change.

The opposition and confliction, interdependency and mutual rooting, waxing and waning, and transformation between yin and yang are the basic components of the yin and yang theory. These compo-

nents are not isolated, but are interrelated, influence each other, and interact as both cause and effect. The waxing and waning of yin and yang theory is a prerequisite for transformation between yin and yang theory, and transformation is the result of waxing and waning^[5].

YIN AND YANG THEORY IN SOFTWARE TESTING THEORY

In terms of computer software testing, yin and yang tests are defined according to the yin and yang theory, and three principles, inherence, mutual inclusion, and transformation of yin and yang tests, will be explained.

Yin and yang tests

Software testing falls into different testing methods from different perspectives. The classification methods that are most likely to be accepted and the most commonly used are black-box and white-box testing, static and dynamic testing, and performance and functional testing^[6,7].

According to the definition of yin and yang, inactive, covert or organic tests are called yin tests, such as static, black-box, and performance testing; and active, overt or functional tests are called yang tests, such as dynamic, white-box, and functional testing. The classification of software testing methods by the theory of yin and yang is shown in TABLE 1^[8].

Inherence of yin and yang tests

Both yin and yang tests exist in the testing of any software product, which is called the inherence of yin and yang tests.

In the development phase, a code review is usually carried out by program developers, which is both static testing (yin test) and white-box testing (yang test). In the unit and integration testing phase, white-box testing (yang test) is often required to check whether reading parameters, structure and other aspects are correct, and black-box testing (yin test) to check whether modules are run correctly are also required. In the system and acceptance testing phase, both functional (yang test) and performance testing (yin test) are performed.

TABLE 1 : Classification of yin and yang tests

Software test category	Software testing method	Attribute
Yin test	Static testing	Inactive: Does not need to run the program.
	Black-box testing	Covert: Does not look at the logical structure and processing procedure within the program.
	Performance testing	Organic: Focuses on time performance, space performance, and stability performance, etc.
Yang test	Dynamic testing	Active: Needs to run the program.
	White-box testing	Overt: Investigates the logical structure and processing procedure within the program.
	Functional testing	Functional: Checks whether the software can meet user requirements in terms of function.

The inherence of yin and yang tests indicates that software testing must have both yin and yang attributes, that is, it is the best to perform both yin and yang tests in order to conform to the inherent attributes and law of testing.

Mutual inclusion of yin and yang tests

A yang test involves factors of a yin test, and a yin test involves factors of a yang test.

In other words, a test that is more yang and less yin is a yang test, and one that is more yin and less yang is a yin test. This is the mutual inclusion of yin and yang tests.

During actual software testing, the factors of white-box testing (yang test), such as structure, parameters, and interfaces of the program, are also considered in the black-box testing (yin test) and the selection of test cases, but the test is more yin and less yang and thus is a yin test. The factors of black-box testing (yin test), such as the relation between input and output when the program is run, are also considered in the white-box testing (yang test), but the test is more yang and less yin and thus is a yang test. Another type of test, called grey-box testing, is a combination of black-box testing (yin test) and white-box testing (yang test), and is almost half black-box and half white-box.

In static testing (yin test), the program is also run in the minds of testers, which is dynamic testing (yang test), but static testing (yin test) is the main form, so it is a yin test. Similarly, during dynamic

testing (yang test), the factors of static testing (yin test) should also be considered, but dynamic testing (yang test) is the main form, so it is a yang test. A test that is almost half static (yin test) and half dynamic (yang test) can be called a yin-yang test.

Similarly, performance testing (yin test) must be considered in functional testing (yang test), and vice versa.

Transformation of yin and yang tests

Changes of yin and yang tests, if any, are often directed to the opposite test. Changes of a yang test are often directed to a yin test, and vice versa. A yang test can be transformed into a yin test when changed to the extreme, and vice versa. This is the transformation of yin and yang tests.

According to the aforementioned principle of mutual inclusion of yin and yang tests, if too many factors of white-box testing (yang test) are considered in black-box testing (yin test), the black-box testing (yin test) will ultimately be transformed into white-box testing, and vice versa. If too many factors of static testing (yin test) are considered in dynamic testing (yang test), the dynamic testing (yang test) will ultimately be transformed into static testing (yin test), and vice versa. If too many factors of performance testing (yin test) are considered in functional testing (yang test), the functional testing (yang test) will ultimately be transformed into performance testing (yin test), and vice versa.

The mutual inclusion and transformation of yin

TABLE 2 : Involvement and proportions of yin or yang testing

Test category	Test form	Involvement of yin testing	Proportion	Involvement of yin testing	Proportion	Note
Universal test	Subroutine testing					
	Unit testing					
	System testing of the entire application					
	New function testing					
	Regression testing					
	Integration testing					
	Virus protection testing					
Special test	Pressure or ability testing					
	Performance testing					
	Safety testing					
	Platform testing					
	Supply chain testing					
User testing	Third-party testing					
	Customer acceptance testing					
	Site (Beta) testing					
	Usability testing					
	Laboratory testing					
	Cleanroom statistical testing					

and yang tests indicate that the attributes and requirements of the software to be tested should be fully considered during selection of software testing models and methods, in order to develop a sound testing plan design.

APPLICATION OF YIN AND YANG SOFTWARE TESTING

Application of yin and yang software testing is discussed below.

Method of test model selection and testing workload estimation

The core method of software testing model selection based on the theory of yin and yang testing is described as follows:

- List the 18 common forms of software (or functional module) testing reported by the Software Productivity Research (SPR)^[9], and determine

the involvement and estimated proportions of yin and yang testing in each testing form.

- Assess the risk likelihood and severity of the software product (or each functional module) according to the identified main factors influencing risk likelihood and severity, and represent them by weights.
- Determine the number of stages of testing to be carried out based on user requirements, time, and other factors.
- Determine the testing methods and workload via comprehensive calculation based on the above information, to develop an appropriate testing strategy and determine the testing focus of each functional module.

Implementation of test model selection and testing workload estimation

According to the Software Productivity Research (SPR), there are 18 common used forms of software

FULL PAPER

TABLE 3 : Testing methods and workload

Test category	Test form Subroutine testing	Yin testing			Yang testing				
		To be performed or not	Proportion	Total weight	Testing workload %	To be performed or not	Proportion	Total weight	Testing workload %
Universal test	Unit testing								
	System testing of the entire application								
	New function testing								
	Regression testing								
	Integration testing								
	Virus protection testing								
	Pressure or ability testing								
	Performance testing								
	Safety testing								
	Special test	Platform testing							
Supply chain testing									
Third-party testing									
Customer acceptance testing									
Site (Beta) testing									
User testing	Usability testing								
	Laboratory testing								
	Cleanroom statistical testing								
	Test form								
Total									

testing, as shown in TABLE 2. This study was performed based on the 18 forms of software testing.

Whether yin or yang testing should be performed for each form of test was determined by the test team

after discussion^[10].

According to the above theory of yin and yang testing, each test contains both yin and yang test attributes. Therefore, whether either, both or none of yin and yang testing should be performed for each form of test, which was represented by the proportions of yin and yang testing, was determined by the test team after discussion based on the specific circumstances and requirements of the test project TABLE 2. The proportion ranges from 0 to 100, where 0 represents not conducting the test, while 100 represents only conducting the test. Other values between 0 and 100 represent the proportion of yin or yang testing in the test form. The sum of the proportions of yin and yang testing is 100.

Routine risk assessment was completed by calculation of risk likelihood and severity, which is affected by various factors. For example, factors to be considered for risk likelihood include complexity of test object, time pressure, geographical dispersion (e.g., development and testing are not performed in the same country), and resources; risk severity can be assessed by frequency of use and visibility of failure of the test object.

The next was to determine the weights of yin or yang testing. Weights were determined by a combination of factors, including frequency of use, visibility of failure, complexity, time factor, and resource factor. The weight of each factor ranges from 1 to 10, and is determined by the test team after discussion based on the actual situation of the project.

The number of testing stages to be performed was determined according to user requirements, time factor and other facts, as well as empirical data. A value of 0 was assigned to a testing stage not to be performed, and 1 to a testing stage to be performed, which was to be entered the column "To be performed or not" in TABLE 3.

The yin testing workload of each test method = "To be performed or not" * "Proportion" * "Total weight." The yin testing workload of each test method % = yin testing workload of each test method/yin testing workload of all test methods. Similarly, the yin testing workload % can be calculated. Test methods and assignment of testing workload are shown in TABLE 3.

In TABLE 3, a testing workload % of 0 indicates that the test stage is not performed, and other values indicate the proportion of the test. Actual testing can be carried out in accordance with the testing methods and workload listed in TABLE 3.

EXPERIMENT

The yin-yang software testing method described above was applied to the testing of the Emergency Exercise software, and compared with the traditional testing method.

A total of 202 test cases were used with the yin-yang software testing method, and 45 defects were found; and a total of 330 test cases were used with the traditional testing method, and 33 defects were found. Testing result was improved by 4.44% and workload decreased by 38.78% with the yin-yang software testing method.

According to the testing result and workload in the experiment, the yin-yang software testing method is reasonable and effective, especially in the testing of medium to small-scale programs.

CONCLUSION

In this study, yin and yang tests were defined based on the philosophical and dialectical thinking of the yin and yang theory in ancient Chinese culture, and applied to a specific software test. Favorable experimental results were achieved in the comparative experiment. Further efforts will be made to improve the yin-yang software testing method, in order to enhance the effectiveness and applicability.

ACKNOWLEDGEMENTS

This study was funded by the Research on Modern Vocational Education System Construction Strategy and Talent Demand in Industrial Restructuring and Upgrading (2012WYXM_0069), a General Project of Humanities and Social Sciences Research of the 2012 Special Fund for Discipline Construction of Guangdong Province; and the Project of Game Software Major of the second batch of 2014

FULL PAPER

Guangdong Provincial Key Major Construction Projects of Higher Vocational Education ([2014] Document No. 85).

REFERENCES

- [1] Zhang Jianan; Chinese ancient philosophy, Hunan Science and Technology Press, (2009).
- [2] Chen Rongrong, Weri Musen; Rethinking on the theory of yin and yang and five elements, Scientific Chinese, (2000).
- [3] Zhang Mingyi; Full Textbook of Chinese literature, Wuhan press, (2010).
- [4] Du Baorui; The elementary philosophy problem in "Yi Zhuan", Zhou Yi Research, 4 (1999)
- [5] Hao Wanshan; The basis of Yin-Yang theory in traditional Chinese medical science, China natural medical science magazine, 2(2), 1 (2000).
- [6] Zhao Bin; Software Testing technology classic tutorials, Science Press, (2007).
- [7] Jiang Fangchun; Software Test Design and Implementation, Peking University Press, (2010).
- [8] Jiang Fangchun; The theory of yin and yang in software testing theory, The Sixth China Testing Conference Proceedings, (2010).
- [9] Capers Jones[US]; interpreted by Liu Congyue, Hao Jiancai, Shen Dongkai, Software Project Estimation 2nd Edition, Publishing house of electronic industry, (2008).
- [10] Fangchun Jiang, Yunfan Lu; Software testing model selection research based on Yin-Yang testing theory, ICSNCE (2012).