

## **Research on Aorbco Model**

Junmin Luo, Wenhua Lu

School of Computer Science and Engineering, Xi'an Technological University Xi'an P.R. China,  
710032

robertjm@126.com

**Keywords:** Consciousness-only; AI; The digital world; The pattern world; AORBCO

**Abstract.** The characteristics of human mind are summarized up after the structure, functions and the working procedure of the eight consciousnesses and the human knowledge structure in consciousness-only psychology have been introduced. The limit of artificial intelligence, processing the formalized partial information, is proposed based on the analysis of elements of human intelligence simulated with computers and the development tendency of programming languages. The digital world model and the relationship among the seeds world, the reality world and the pattern world have been put forward after the position of the digital world (AI) in the human mind structure is discussed. AORBCO model, a formalized method with which the digital world is described has been advanced. The elements of AORBCO model-Agent, Object and Relationship have been defined after the investigation of AI research. It is the conclusion of this paper that AORBCO model is a theoretical basis for integrating the methods used in AI and making computers more intelligent.

### **Introduction**

It is generally known that the prime purpose of inventing electronic computers is for science computing. Human intelligence is needed in science computing. From then on human has presumed upon that the computers would do more things that are done by human with his intelligence. Impelled by the hypothesis, the generations of computers are having been updated. Enlarging memory capacity, improving computing speed and controlling the more and more I/O device types are the development tendency of hardware. The focus on basic elements of software is from function modules, through objects to agents [5]. The evolution of computer architectures is from single computers, through networks and distributed systems to MAS [2]. It is a great achievement for human to simulate his self intelligence with computers used in many aspects of our life. It is the introduction of the concepts of agents, MAS and the research for the mind status and the sociability of agents that have enhanced the degree of similarity between computer intelligence and human intelligence [3,4]. Then what is the structure of human mind? How does it work? Is it possible to simulate human intelligence as a whole with computers? Which parts and which functions of human mind have been simulated up till now? Where is the position of all computer intelligence (called as the digital world) in the human mind? What is the structure of the digital world? What is the relationship between the reality world and the digital world? How much has the digital world been studied? What are the problems in the research of the digital world? What method and what tool can be used to describe the digital world with to integrate the existed methods and tools better, to solve the problems more effectively and to make computers more intelligent? These are the issues discussed from aspect of consciousness-only psychology in this paper.

### **Structure of Human Mind Based on Consciousness-only Psychology**

**Structure of the Eight Consciousnesses.** In consciousness-only psychology, everything in the cosmos including physical and spiritual, existent and un-existent, reality and nihility, etc. are called as Dharma. The form and implication of Dharma are called as Character, Dharma and Character as a whole are called as Faxiang [1, 9].

Human mind is divided into eight consciousnesses which describe the structure of mind more accurately in consciousness-only psychology. They are the eighth consciousness (Alaya Consciousness), the seventh consciousness (Manas Consciousness), the sixth consciousness (Thought Consciousness), the fifth consciousness (Tactile Consciousness), the fourth consciousness (Gustatory Consciousness), the third consciousness (Olfactory Consciousness), the second consciousness (Auditory Consciousness) and the first consciousness (Visual Consciousness). The structure of the eight consciousnesses is illustrated in Fig. 1. Faxiang is regarded as the appearance of the eight consciousnesses' functions in consciousness-only psychology, which is called as Faxiang-Consciousness- only for short.

In the structure the eighth consciousness is also called as the Repository Consciousness. There are three meanings included in it. (1) Subject-store: The eighth consciousness can store everything in it. (2) Object-store: The eighth consciousness is a storehouse where everything is stored. (3) Attachment-store: The eighth consciousness keeps everything in it from vanishing and mistake.

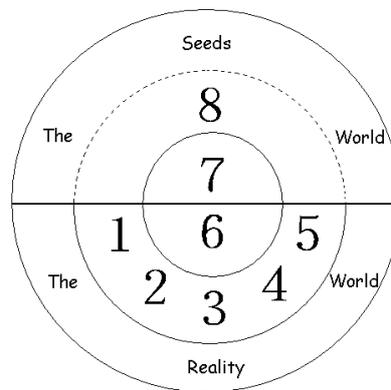


Figure 1. Structure of eight consciousnesses

The seventh consciousness is also called as the Self Consciousness. One of its primary functions is to perceive the subjective position of the eighth consciousness and to regard it as one's own ego erroneously, thereby to create ego attachment. "An ego" means that a person possesses a permanently unchanged subject and some capability so that the person has made a distinction between himself and the environment all around.

The sixth consciousness is also called as The Discriminatory Consciousness which bases on the seventh consciousness. It is able to gather the sense data derived from the prior five sense consciousnesses, to discriminate all the aspects of the environment, to generalize the entire idea of the environment, to analyze it with the past experiences, to form judgment and to control the five organs to react to the environment. The procedure is called as the simultaneous-six-consciousness because the sixth consciousness and one or more of the prior-five consciousnesses take part in it. Consciousness-only psychologists regard the environment and the organs participated in the simultaneous-six-consciousness as a showing of the past experiences that have been stored in the eighth consciousness while conditions are appropriate. Except the simultaneous-six-consciousness there is another consciousness phenomena called as the only-sixth- consciousness. The prior-five consciousnesses do not participate in only-sixth-consciousness, such as thinking and dreaming, etc. In only- sixth-consciousness the objects of sense are the absolute images that have been stored in the eighth consciousness.

The prior five consciousnesses-the visual consciousness, auditory consciousness, olfactory consciousness, gustatory consciousness and tactile consciousness refer to the five sense functions of the five sense organs-eyes, ears, nose, tongue and skin respectively.

**Functions of Eight Consciousnesses.** In consciousness-only psychology the functions of the eight consciousnesses are divided into five categories, among which there are fifty-one. They are:

First the five pervasive functions that exist and operate in all places and times.

1) Contact: the mental function that brings consciousnesses to contact with external situation. It is the premise of sensation, perception and volition.

2) Attention: the mental function that alarms consciousnesses to be care for external objects. Contact means that the mental functions are produced from the external objects. Attention means that the external objects are produced from the mental functions. The relation between Attention and Contact is like the relation between an acting force and an anti-acting force.

3) Sensation: the feeling from Attention and Contact, such as happiness, agony, etc.

4) Perception: the mental function that analyses the environment and form concepts.

5) Volition: the reaction to the environment.

The five pervasive functions act in succession. One is stirring while another follows.

Second the five special functions which arise according to the various objects or conditions. A special mental function judges special objects. The five special functions are the complement of the five pervasive functions.

1) Desire: the mental function that hopes to receive the objects that the mind likes.

2) Deciding: the mental function of making clear exactly what the object is.

3) Recollection: the operation of the mind of not forgetting an object.

4) Concentration: the operation of the mind of concentrating an object.

5) Judgment: the mental function of discriminating, estimating relative and absolute facts, cutting off doubt.

Third the eleven good functions which are the mental functions of doing goodness.

1) Faith.

2) Vigor.

3) Shame: the mental function of feeling shame expressed towards others for one's own misdeeds.

4) Self-accusation: refers to the shame resulting from reflecting on one's self-centered evil actions.

5) Absence of greed.

6) Absence of hate.

7) Absence of foolishness.

8) Light-ease.

9) Non-laxity.

10) Renunciation: the mind functions as impartial and free from frenzied movement.

11) Non-harming.

Fourth the twenty six affliction functions which are the mental functions of doing evil.

1) The six fundamental afflictions:

(1) Greed.

(2) Hatred.

(3) Foolishness.

(4) Pride.

(5) Doubt.

(6) Erroneous-views.

2) The twenty subsidiary afflictions:

i. The ten lesser afflictions:

(1) Anger.

(2) Enmity.

(3) Vexation.

(4) Concealing.

(5) Deceit.

(6) Flattery.

(7) Haughtiness.

(8) Harming.

(9) Jealousy.

(10) Stinginess.

ii. The two middling afflictions:

(1) Absence of conscience.

(2) Absence of shame.

iii. The eight greater afflictions:

(1) No-faith.

(2) Laziness.

(3) Indolence.

(4) Depression.

(5) Flightiness.

(6) Forgetting.

(7) Incorrect-knowledge,

(8) Scattering.

Fifth the four indeterminate functions which are the mental functions arising irregularly and not having a predilection for good or evil.

1) Remorse: reflecting on one's own prior actions.

2) Torpor.

3) Investigation: the function of the mind that gives a general view of a thing.

4) Analysis: the mental function of examining the principle of a thing in detail. It is the complement of Investigation.

The five pervasive functions are common functions of the eight consciousnesses. The eighth consciousness possesses this group of functions only. The sixth consciousness possesses all fifty-one functions. The seventh consciousness possesses Judgment and twelve affliction functions besides the pervasive functions. The prior five consciousnesses possess thirteen affliction functions besides the pervasive functions, the special functions and the good functions.

**Working Procedure of Human Mind.** According to the consciousness-only psychology, the reality world that we sense including our body, our mental action and the environment all around us (called as Actuality briefly) is a manifesting of the past experience impression that has stored in the eighth consciousness and possesses some potential (called as Seeds briefly) when the conditions are all prepared. Therefore it is a fact that the prior seven consciousnesses are the effect caused by the seeds in the eighth consciousness. At the same time the actively prior seven consciousnesses that possess some potential as Seeds are stored by the eighth consciousness. Thus the eighth consciousness as Seeds and the prior seven consciousnesses as Actuality are cause-effect each other. This simultaneous cause-effect relation is summed up as follows:

1) Seeds cause Actuality.

2) Actuality causes Seeds.

3) Seeds cause Seeds.

4) Actuality causes Actuality.

The seventh consciousness which grasps the storing and manifesting functions of the eighth consciousness as 'a internal self' is a continuous connector between the eighth consciousness and the prior six consciousnesses. As basis of the prior six consciousnesses' functions it runs through the mental activity of the prior six consciousnesses.

The prior five consciousnesses receive the objects of form, sound, smell, taste and touch respectively and formalize intuition. Having discriminated the objects, formalized sensation and generated concepts, the sixth consciousness analyzes the environment, reasons, judges and reacts to the environment. In fact, the intuition formalized by the five senses has changed when the sixth consciousness formalizes the sensation. That is, an updated situation shows continuously and analogically. Thereby there is a deviation between the objects of our sixth consciousness and the reality world. The mental activity of our sixth consciousness is a shadow of the reality world.

**Relationship among Ones' self Consciousness and Others'.** The issue we have discussed above is ones' self consciousness. In fact, other individuals are part of ones' self environment in his consciousness while a person is part of others' environment in their consciousnesses. Therefore it

opens up a magnificent cosmic prospect, in which 'I' as a part is in 'You' and 'You' as a part is in 'I'. One is all and all is one. There is neither any object and nor any subject. Everything is totally equal in nature. As a matter of fact, the eight consciousnesses are hypothesis for talking conveniently, because every consciousness consists of many factors. If there were not these factors, there would be not any consciousness. Let's look at the subject, including our body and mind, which is possessed by an individual and different for each other. The body is the common part in the special part for it can be perceived by others. The neural system is the special part in the special part for it can't be perceived by others. The object, the environment around us, is possessed by the all members living in it. The land or houses are the special parts in the common parts for the relations between every one and others are close or loose, but the sun, the moon and the stars are the common parts in the common parts for they are possessed by everybody.

**Knowledge Structure.** Human knowledge is divided into 'subject' and 'object' in the consciousness-only psychology. The subject refers to the cognition capability of human mind. The object is what has been known. Everything is included in the object and the subject is a part of the object. Otherwise if the subject was not the object, the subject would not know that the subject itself has the cognition functions. The relation between 'subject' and 'object' shows in Fig. 2.

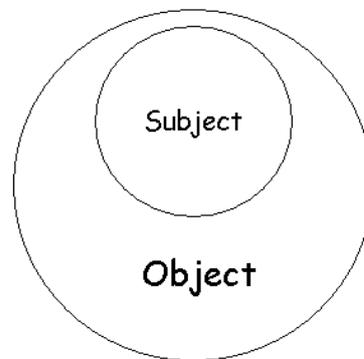


Figure 2. 'Subject' v. 'object'

In detail human knowledge can be divided into five classes in the consciousness-only psychology.

First, Mind: there are eight kinds which are discussed in section 2.1.

Second, Mental Properties: there are fifty-one kinds which are discussed in section 2.2.

Third, Material Existence, there are eleven kinds:

- 1) Sight Organ.
- 2) Sound Organ.
- 3) Smell Organ.
- 4) Taste Organ.
- 5) Touch Organ.
- 6) Sight Object.
- 7) Sound Object.
- 8) Smell Object.
- 9) Taste Object.
- 10) Touch Object.

11) Mind Object: all material elements that are included as objects of the six senses not covered under the categories of the five organs and the five objects. That is, there are some objects of the mind which are included as material elements.

Fourth, Elements Not Concomitant with Mind: there are twenty-four elements, every one consist of 1st, 2nd and 3rd groups.

- 1) Acquisition.
- 2) Life Potential.
- 3) Uniformity.
- 4) Individuality.

- 5) Mental Training Leading to Unconsciousness.
- 6) Mental Training Leading to The Cessation of All Existence.
- 7) Unconsciousness.

8) Words indicating the nature of things.

9) Sentences indicating the differences or relations of things.

10) Letters--basis of words and sentences. The words and the sentences in spoken languages are depended on sounds. The words and the sentences in written languages are depended on forms. The words and the sentences in thought are depended on Mind Objects.

11) Birth, one thing is manifested when conditions are satisfactory.

12) Decay.

13) Abiding.

14) Death: one thing is disappeared when conditions are broken off.

15) Continuity: to continue in the action of cause and effect without stopping.

16) Distinction: the principle that the causes of good do not cause the effects of evil and the causes of evil do not cause the effects of good.

17) Correlation: the principle that the causes of good cause the effects of good and the causes of evil cause the effects of evil.

18) Instantaneousness: an element provisionally established on the rapid energy of conditioned elements to arise and cease without an instant of pause.

19) Order: the provisionally established capacity of conditioned elements in their arising and ceasing, to follow the order of before and after in regard to cause and effect.

20) Space.

21) Time.

22) Number.

23) Harmonization.

24) Disharmony.

Fifth, Unconditioned Existence: the nature that is manifested through 1st, 2nd, 3rd and 4th groups. There are six types:

1) Omnipresent Ether.

2) Conscious Cessation.

3) Unconscious Cessation.

4) Immovability.

5) A state of trance in which both ideation and feeling cease.

6) Suchness or the True Nature.

1st and 2nd parts in our knowledge are the subject. The knowledge as we call normally is a part of the prior four classes, that is, the part we have recognized. Others are the parts we haven't recognized. Although there are parts of knowledge we haven't recognized, they act on our life too.

Is the knowledge we have acquired true or not? According to the consciousness-only psychology, the knowledge we have acquired is divided into three catalogues:

1) The knowledge we perceive directly without interference from conceptualization or predispositions (Perception).

2) The knowledge we have acquired with inference from conceptualization or predispositions (Ratiocination). For instance, seeing smoke, we know there is fire.

3) The knowledge we have acquired is false (Misconception). For instance, seeing a rope, we take it for a snake.

The knowledge we sense with the eighth consciousness and the prior five consciousness is Perception. The knowledge we have acquired with the seventh consciousness is complete Misconception. The knowledge we have acquired with the sixth consciousness is Perception, Ratiocination or Misconception. Therefore the knowledge structure of human discussed in the consciousness-only psychology is a stereoscopic, dynamic, holographic and entire structure of the universe.

**Characteristics of Human Mind.** Through discussing above the characteristics of human mind can be summed up as follows:

1) The unity of a whole and its elements. All phenomena are caused by the mutual relationships of countless causes and conditions and are not independently existent. If all causes and conditions did not exist, no results would come into existence. This is the key characteristic and others can be deduced from it.

2) The unity of oneself and others, the unity of individuals and the society. 'I' as a part is in 'You' and 'You' as a part is in 'I'.

3) The unity of parallel and serial. The concurrence of the eight consciousnesses, the sixth consciousness sensation to the reality world lags behind manifesting for the reality world of the eighth and the prior five consciousnesses.

4) The unity of truth and falseness. Perception of the eighth consciousness and the prior five consciousnesses, Misconception of the seventh consciousness, Perception, Ratiocination or Misconception of the sixth consciousness.

5) The unity of continuity and discontinuity. The actions of the seventh and the eighth are continuing, while the actions of the prior five are interval.

6) The unity of restriction and activation: the restriction of the past seeds for Actuality, the activation of Actuality as seeds for the future Actuality.

### **Simulating Functions of Human Mind with Computers**

Human mind is a unity of the subject and the object, so it is equal to the complete universe. Everything in the cosmos depends on the existence of others. If there did not exist others, none any individual could come into existence. The facts, the sensation to the reality world of the sixth consciousness lags behind manifesting for the reality world of the eighth and the prior five consciousnesses, and the seventh consciousness perceives erroneously the functions of the eighth, let us cognize the partial falseness of the knowledge we have acquired and the unsuitableness of the methods with which we acquire the knowledge. What are the right methods we can use to get the knowledge? What knowledge is true? These problems are worth studying deeply <sup>[1,9]</sup>.

According the discussing above, we can say that it is impossible to simulate human mind completely for it is equal to simulate the whole world. If we say that the computers haven't any intelligence, neither the experts of computers nor the users of computers agree with it. How does the conflict come into being? The reasons are as follows:

1) We haven't understood the structure and functions of human mind entirely.

2) We enlarge the capability of computers which can do something which human does with intelligence, so we hope that computers could do everything which human does with intelligence.

It is our answer that the computers can't simulate the actions of human mind completely forever, but they can do some works that human does with intelligence, specially, in some aspects they can do better than human. Then what intelligence of human do the computers simulate? Essentially, they simulate tow functions: the memory function and the automatic processing function.

**Simulating Memory Function with Storing Data and Programs.** The method human stores information with is holographic. That is, the information is stored in the eighth consciousness with entire and indifferent form. Although every consciousness possesses this function, the eighth is the strongest. Computers can only store the strictly formalized partial data that the users interest in. The strictly formalized data is the data expressed with strings that consist of 0 and 1 only. The development tendency of the storage technology is to enlarge the capacity of memories, such as the photon-storage, the quantum-storage and the atom-storage etc.

**Simulating Automatic Processing Function with Executing Programs.** The automation of processing information of human mind is born of the simultaneous cause-effect relationship between the seeds in the eighth consciousness and the actuality of the prior seven consciousnesses. It is holographic, that is, if conditions are ready the seeds cause the actuality and meanwhile the actuality causes the seeds. The automatic execution of programs is decided on the addressing machinery of the instruction systems of computers. The development tendency of the automatic

execution technology of programs is to improve the computing speed, such as the parallel-computing, the photon-computing, the quantum-computing and the atom-computing etc.

### **Abstracting Intelligence of Computers with Programming Languages**

The computers have helped human to do some intelligence works through simulating the memory function with storing data and simulating the automatic processing function with executing programs. If human wants a computer to help him with some works, human must plan each step work (an instruction) a computer will do, which is called as programming. The whole instructions a computer can execute are the entire basic functions a computer possesses, therefore the instruction set of a computer is abstraction of the intelligence of the computer.

**Machine Languages.** Indicating the high and low electrical levels which are the basic states of a fundamental unit of a computer with 0 and 1 and encoding the instructions and the addresses of a computer with the strings which consist of 0 and 1 only, thus the lowest level programming language (a machine language) has been formed. The machine language is the first level abstraction of intelligence of a computer. The physical meaning of the instructions has been fixed in advance when the computer was designed. The meaning of the instruction sequences and the memory contents is defined by the programmers when programming with the machine language.

**Assembler Languages.** In the assembler languages, the instructions and addresses in the machine languages is encoded with special words or character strings. With the help of the assemblers the programmers are liberated from the affliction of remembering the strings which consist of 0 and 1 only. Therefore the assembler languages are abstraction of the machine languages and are the second abstraction of intelligence of computers. The physical meaning of the words or strings used in the assembler languages has been fixed with the logic meaning of the instructions in the machine languages and the functions of the assemblers. The functions of the programs programmed with the assembler languages are defined by the programmers.

**High-level Languages.** In the high-level languages, the logic structures of data and the operation sequences commonly used in the programs programmed with the machine languages or the assembler languages are induced and abstracted as data types and statements which are encoded with some special words or symbols called as reserved words whose meanings are close as far as possible to the meanings in English. The physical meaning of the elements in the high-level languages has been fixed with the logic meaning of the instructions in the machine languages and the functions of the compilers. The functions of the programs programmed with the high-level languages are defined by the programmers. Therefore the high-level languages are the masterly generalization of intelligence of computers and are symbol systems for writing which combine the codes with the meanings.

There have been more than one thousand high-level languages designed, more than five hundred realized and more than twenty in common use. There are so many high-level languages because of the widespread application of computers and the different views which human solves problems with. These views are the procedure model, the function model, the logic model and the object model. The corresponding languages are the procedure model language, the function model language, the logic model language and the object model language.

In the procedure model languages, to solve a problem with computers is regarded as to solve the problems that are the partial elements of the whole problem. The actions and members participating in solving the problem are abstracted as procedures and data. The earlier high-level languages almost belong to this model.

In the function model languages, to solve a problem with computers is regarded as to map a domain to another one, the problem to be solved is divided into sets of members participating in solving the problem and the relationships of the sets. LISP is a typical example.

In the logic model languages, to solve a problem with computers is regarded as to obtain certain conclusion by inference from some facts and rules, the problem to be solved is described as sets of facts and rules. PROLOG is a typical example.

In the object model languages, to solve a problem with computers is regarded as to get the result from the interaction of all individuals participating in the problem, the problem to be solved is described as sets of objects and the interactions among them. SMALLTALK is a typical example.

Although there are numerous kinds of the high-level languages, there are two restrictions on the emergence and the development of them. One is the equality of the physical machine that the languages have been realized with. Another is the identity of the reality world that is abstracted and described with the languages. There are so many kinds of high-level languages, because there are different manifestation forms of the reality world in different domains and there are lopsided and subjective views in our thought when we recognize the world.

**Super Languages.** With the popularizing of computer networks and the deeply studying of DAI, programming languages that possess stronger functions to describe the intelligence of computers are more required so that people may develop and apply the computer resources easily. A whole program which is designed to solve a problem with a high-level language is abstracted as an agent. A system which consists of some agents which interact mutually is abstracted as a MAS (Multi-Agent System). A set of rules describing the integrants that an agent consists of and the interactions between agents in a MAS is called as a super language<sup>[6,7,8]</sup>. The agents which have the function of experience-replaying only are called as reactive agents while the agents which not only have the function of experience-replaying and also have the function of experience-recollecting are called as intelligent agents. Experience-replaying is defined as that the agent can do the works directly with some methods the agent has possessed when some works are assigned to an agent. There are two meanings in experience-recollecting. One is that the agent can not do the works directly with some methods the agent has not possessed but the agent can obtain from learning or reasoning and recollect in his knowledge base when some works are assigned to an agent. The agent can do the same works with the methods sometime later. Another is to recollect the proficient degree of the methods the agent uses. Therefore BDI-Agents are special examples of intelligent agents.

According to discussing above, the development tendency of programming languages is to improve the degree of data abstraction and programming automation.

### **Processing Formalized Partial Information -- Limit of Artificial Intelligence**

With the deep research on agents and MAS, people has summed up and is working hard to finish some anthropomorphic characteristics of agents, such as the autonomy, the adaptability, the aim guidance, the environment reactivity, the sociability and the mobility, etc. It seems some day agents would change into human being or the society composed of agents. That is, MAS would control and replace the world. This is impossible. Because the abstract functions of programming languages and the popularization of computer are never beyond the basic intelligence of computers, the strictly formalized data storage and the restricted capability of the instruction sets. That is, processing the formalized partial information is the limit of artificial intelligence. The methods with which human stores and processes information are holographic. It means:

- 1) Storing and processing the entire information which exists in every time and every place.
- 2) The parallel between storing and processing, similar to ANN, but the information in ANN is partial yet.

As a result, besides digitalizing the external world, improving the intelligence of computers and serving human being, it is more important that we must train our minds to unify the subject and the object, let the original wisdom in our minds shine.

### **Position of Digital World in Human Mind**

All phenomena are brought on due to the mutual relationships of countless causes and conditions and every thing does not independently exist, which is the premier characteristic of human mind. If all causes and conditions did not exist, no results could come into being. The digital world is a part of the reality world that is formalized with computer technologies, communication technologies and

other relevant technologies. Meanwhile it is the manifesting of the seeds stored in the eighth consciousness. The position of the digital world in our consciences is shown in Fig.3.

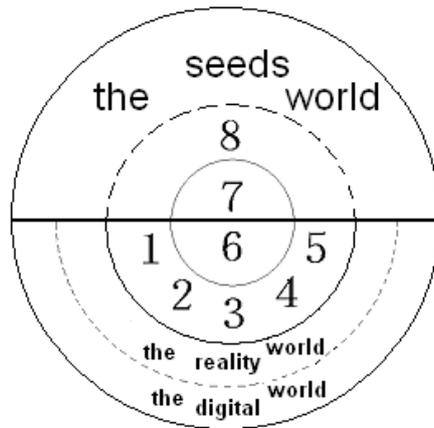


Figure 3. Position of digital world in our consciences

1-8 in Fig.3 indicate Visual Consciousness, Auditory Consciousness, Olfactory Consciousness, Gustatory Consciousness, Tactile Consciousness, Thought Consciousness, Manas Consciousness and Alaya Consciousness. The seeds world is an organic set of experience impressions that are some latent functions stored in the eighth consciousness. The reality world is an organic set of our body, our thought and the environment surrounded us. The digital world is an organic set of computers and information stored in and processed with computers. The dotted arc between the digital world and the reality world indicates that the digital world is a part of the reality world and is a partial map of the reality world too. The dotted arc between the seeds world and the eighth consciousness indicates that the seeds world is as content stored in the eighth consciousness. The line indicates that all parts in Fig.3 are related with each other.

### Model of Digital World

The digital world is a product which human kind produce with the matter manifested from his mind to simulate the function of his mind. The structure of the digital world must be stamped with the brand of the structure of human mind and is a formalized partial map of the structure of human mind. The model of the digital world is shown in Fig.4.

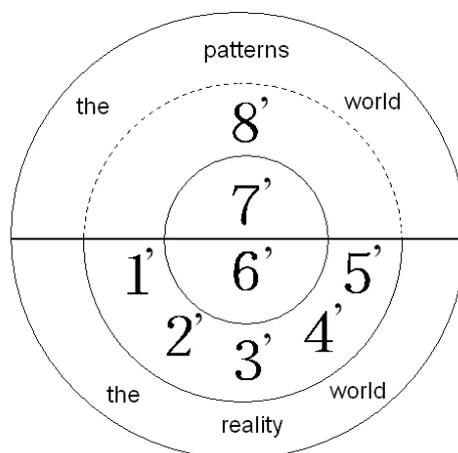


Figure 4. Limit model of digital world

In Fig.4, 1'-5' are perception mechanisms which simulate the function of the prior five consciences; 6' is a reasoning mechanism which simulate the function of the sixth consciousness; 7' is a personality mechanism which simulate the function of the seventh

consciousness; 8' is a mechanism which simulate the function of the eighth consciousness to match and access the patterns; the patterns world is the formalized partial expression of the reality world. Therefore the digital world is regarded as an intelligent agent who simulates a human.

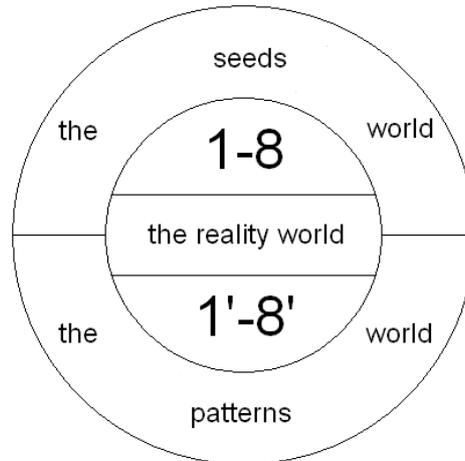


Figure 5. Relation of three worlds

If the digital world in Fig.3 is substituted for Fig.4, we may get the relation among the seeds world, 1-8 consciousnesses, the reality world, 1'-8' mechanisms and the patterns world in Fig.5.

### CURRENT Research of Digital World

Although the research for the structure of human mind is not more deeply and more carefully in the computer science than in Consciousness-only Psychology, no thing we see, we hear, we say, we think of and we do is not the manifesting of functions of our mind, so the computer technology will be limited within the digital world.

**Simulating Function of the Prior Five Consciousnesses.** There are more and more sensory devices simulating the function of the prior five consciousnesses [21]. Especially the visual performance and the auditory performance have been studied more deeply, but the information from sensors must be formalized first before storing in computers and processing.

**Simulating Function of the Sixth Consciousness.** The reasoning mechanisms such as the classical logic and the classical inference, the non-classical logic and the non-classical inference have been studied more carefully. Especially open logic[22] and non-monotonic logic[23], case-based reasoning[24] and Bayesian-network[25], fuzzy reasoning network[26] and comprehensive reasoning[10] are closed to the methods which human reasons with.

**Simulating Function of the Seventh Consciousness.** The personality mechanisms--the characteristics of Agents, such as autonomy, adaptability, aim guidance, environment reactivity, sociability, mobility and the feelings, have been studied step by step[11].

**Simulating Function of the Eighth Consciousness.** There are more and more patterns in the patterns world: from number, char, array, set, structures defined by users to object and framework; from text, graphic, image to animation and video. The volumes of patterns are bigger and bigger: from instruction, procedure, program to process and agent; from single computer, network, distributed system to grid and MAS; from expert, domain, ontology [13] to commonsense[14] and semantic WEB[15]. The methods for describing patterns are more and more: from predicate logic, rule, semantic network, framework to object-oriented technology and neural network [16].

### Problems in Research of Digital World

**Integrating Functions.** Simulating the functions of the eight consciousnesses as analyzed above has been referred to in the computer technology, but they have been studied in different domains and have not integrated in one unity, so the whole ability dose not be formalized. Human

intelligence can be branched out into the eight consciousnesses, for the more, can be branched out into one hundred Dharma's, further, can take on an infinite variety of form, it is one unity but.

**Expressing and Understanding.** Because of the diversity of too many methods for describing patterns, there exists the diversity of methods to interoperate each other, which is called as pattern comprehension or semantic of patterns. Expressing knowledge in human mind is holographic, that is, the outwards of knowledge are variety, but the essence is one.

**Consistency and Expansion.** When the semantics of the digital world disaccords with the semantics of the reality world the digital world must be expanded to match the reality world, which is an aspect of machine learning. If a person can recognize the relation between himself and the reality world correctly, make his view on the reality world follow the change of the reality world and let himself coordinate with surrounding environment, the confliction between himself and surrounding environment will not exist, which is called as adaptability.

**Man-machine Integration.** The interest models of users must be installed in computers as intelligent agents for users so that computers can be used easily. The interest models of users includes understanding users, understanding the patterns world and recalling the frequency of using patterns which is another aspect of machine learning. The education functions of users to the digital world must be included in man-machine integration.

### AORBCO—A Formalized Model to Describe Digital World

Through analyzed above we think that a suitable formalized model to describe the digital world must be a theoretical basis for integrating the models used in AI, resolving the problems in AI and making computers more intelligent, so we put forward AORBCO model (Agent Object Relationship Based on Consciousness-Only Model) as follows:

#### Definition 1. Digital World

Let  $DW(t)$  indicate the state of the digital world at time  $t$ ,

$A(t)$  indicate the set of agents in  $DW(t)$ ,

$O(t)$  indicate the set of objects in  $DW(t)$ ,

$R(t)$  indicate the set of relations in  $DW(t)$ , then:

$$DW(t)=(A(t),O(t),R(t))$$

Let  $RAA(t)$  indicate the set of whole relations in  $A(t)$ , i.e.,  $RAA(t)= A(t) \times A(t)$  ;

$ROO(t)$  indicate the set of whole relations in  $O(t)$ , i.e.,  $ROO(t)=O(t) \times O(t)$ ;  $RAO(t)$  indicate the set of whole relations between  $A(t)$  and  $O(t)$ , i.e.,  $RAO(t)= A(t) \times O(t)$ ;  $ROA(t)$  indicate the set of whole relations between  $O(t)$  and  $A(t)$ , i.e.  $ROA(t)=O(t) \times A(t)$ ; then:

$$R(t)=(RAA(t),ROO(t),RAO(t),ROA(t))$$

#### Definition 2. Reality World

Let  $RW'(t)$  indicate the part of the reality world described in  $DW(t)$ ,

$A'(t)$  indicate the set of prototypes in  $RW'(t)$  of agents in  $DW(t)$ ,

$O'(t)$  indicate the set of prototypes in  $RW'(t)$  of objects in  $DW(t)$ ,

$R'(t)$  indicate the set of relations in  $RW'(t)$ , then:

$$RW'(t)=(A'(t),O'(t),R'(t))$$

Let  $RAA'(t)$  indicate the set of whole relations in  $A'(t)$ ,

$ROO'(t)$  indicate the set of whole relations in  $O'(t)$ ,

$RAO'(t)$  indicate the set of whole relations between  $A'(t)$  and  $O'(t)$ ,

$ROA'(t)$  indicate the set of whole relations between  $O'(t)$  and  $A'(t)$ , then:

$$R'(t)=(RAA'(t),ROO'(t),RAO'(t),ROA'(t))$$

#### Definition 3. Agent

Let  $a(i,t)$  indicate the state of agent  $i$  in  $A(t)$  at time  $t$ ;  $AA(i,t)$  indicate the set of agents which have been recognized by  $a(i,t)$ , i.e.,  $AA(i,t) \subseteq A(t)$ ;  $OA(i,t)$  indicate the set of objects which have been realized by  $a(i,t)$ , i.e.,  $OA(i,t) \subseteq O(t)$ ;  $RA(i,t)$  indicate the set of relations which have been realized by  $a(i,t)$ , i.e.,  $RA(i,t) \subseteq R(t)$ ;  $H(i,t)$  indicate the set of works which have been done by  $a(i,t)$  until time  $t$ ;  $D(i,t)$  indicate the set of goals which  $a(i,t)$  want at time  $t$  to achieve at sometime  $t_2$  ( $t \leq t_2$ )

2);  $W(i,t)$  indicate the set of works which  $a(i,t)$  is able to do at time  $t$ ;  $CA(i,t)$  indicate the value set of attributes which  $a(i,t)$  possesses at time  $t$ ; Transmigration indicate the inner-mechanism which let the state of  $a(i,t)$  transform, then:

$$a(i,t)=(CA(i,t),AA(i,t),OA(i,t),R(i,t),H(i,t),D(i,t),W(i,t),$$

Transmigration)

Let  $RAAA(i,t)$  indicate the set of whole relations in  $AA(i,t)$ ;

$RAOO(i,t)$  indicate the set of whole relations in  $OA(i,t)$ ;

$RAAO(i,t)$  indicate the set of whole relations between  $AA(i,t)$  and  $OA(i,t)$ ;

$RAOA(i,t)$  indicate the set of whole relations between  $OA(i,t)$  and  $AA(i,t)$ , then:

$$RA(i,t)=(RAAA(i,t),RAOO(i,t),RAAO(i,t),RAOA(i,t))$$

#### Definition 4. Object

Let  $o(i,t)$  indicate the state of object  $i$  in  $O(t)$  at time  $t$ ;  $OO(i,t)$  indicate the set of objects which are related to  $o(i,t)$ , i.e.,  $OO(i,t) \subseteq O(t)$ ;  $OA(i,t)$  indicate the set of agents which are related to  $o(i,t)$ , i.e.,  $OA(i,t) \subseteq A(t)$ ;  $RO(i,t)$  indicate the set of relations which are related to  $o(i,t)$ , i.e.,  $RO(i,t) \subseteq R(t)$ ;  $CO(i,t)$  indicate the value set of attributes which  $o(i,t)$  possesses at time  $t$ , then:

$$o(i,t)=(CO(i,t),OA(i,t),OO(i,t),RO(i,t))$$

Let  $ROAA(i,t)$  indicate the set of whole relations in  $OA(i,t)$ ;

$ROOO(i,t)$  indicate the set of whole relations in  $OO(i,t)$ ;

$ROAO(i,t)$  indicate the set of whole relations between  $OA(i,t)$  and  $o(i,t)$ ;

$ROOA(i,t)$  indicate the set of whole relations between  $o(i,t)$  and  $OA(i,t)$ , then:

$$RO(i,t)=(ROAA(i,t),ROOO(i,t),ROAO(i,t),ROOA(i,t))$$

#### Definition 5. Operation, Response and Interaction

Let  $ARD(t)$  indicate the set of agents in  $RW'(t)$  which use  $DW(t)$  directly, the agents in  $ARD(t)$  are called as users' agents ( $U\_agent$  in short), then:  $ARD(t) \subseteq A'(t)$ ,  $\forall a(i,t) \in ARD(t)$ , if  $W(i,t)$  is the set of works which  $a(i,t)$  will ask  $DW(t)$  to do,  $WRD(t) = \cup W(i,t)$ , then  $WRD(t)$  is called as Operation to  $DW(t)$  which  $RW'(t)$  do at time  $t$ ;

Let  $ADR(t)$  indicate the set of agents in  $DW(t)$  which are used by agents in  $ARD(t)$ , the agents in  $ADR(t)$  are called as interface agents ( $I\_agent$  in short), then:  $ADR(t) \subseteq A(t)$ ,  $\forall a(i,t) \in ADR(t)$ , if  $W(i,t)$  is the set of results which are produced by  $a(i,t)$  through doing the works in  $WRD(t-1)$ , then  $WDR(t) = \cup W(i,t)$ ,  $WDR(t)$  is called as Response to  $RW'(t)$  which  $DW(t)$  do at time  $t$ ;

$(WRD(t), WDR(t))$  is called as Interaction between  $RW'(t)$  and  $DW(t)$  at time  $t$ .

#### Definition 6. Relationship

Let  $e_i$  and  $e_j$  are two arbitrary elements in  $DW(t)$ ,  $R(e_i, e_j, t)$  indicate the relationship between  $e_i$  and  $e_j$  at time  $t$ , then  $R(e_i, e_j, t) = (Id, Ra, Rr, Ri) *$ , in which

An element in  $DW(T)$  is either an agent or an object;

$Id$  is the identification code of a relation between  $e_i$  and  $e_j$ ;

$R_i$  indicate the instantaneous between  $e_i$  and  $e_j$ , the value of  $R_i$  is 0 or 1,  $R_i=0$  indicate there is no relation  $Id$  between  $e_i$  and  $e_j$  at time  $t$ ,  $R_i=1$  indicate there is the relation  $Id$  between  $e_i$  and  $e_j$  at time  $t$ ;

$R_a$  indicate the accumulative relation between  $e_i$  and  $e_j$ , the value of  $R_a$  is  $[0,1]$ ,  $R_a = \sum R_i / t$  means the probability of the relation  $Id$  between  $e_i$  and  $e_j$  in time period  $[0, t]$ ;

$R_r$  indicate the recent relation between  $e_i$  and  $e_j$ , the value of  $R_r$  is  $[0,1]$ ,  $R_r = \sum R_i / \Delta t$  means the probability of the relation  $Id$  between  $e_i$  and  $e_j$  in time period  $[t-\Delta t, t]$ ;

$R_a = R_r = R_i = 0$  means there has never been relation  $Id$  between  $e_i$  and  $e_j$  before time  $t$ , meanwhile there is no term  $(Id, Ra, Rr, Ri)$  in  $R(e_i, e_j, t)$ ;  $R(e_i, e_j, t) = null$  means there hasn't been any relationship between  $e_i$  and  $e_j$  before time  $t$ .

#### Definition 7. Experience, Goal and Plan

Let  $H(i,t)$  indicate the Experiences which  $a(i,t)$  has attained until time  $t$ , then:

$$H(i,t) = (a(i,t_1)Ws(i, t_1, t_2)a(i,t_2)) *$$
, in which:

$$t_1 \leq t_2 \leq t,$$

$Ws(i, t_1, t_2)$  is a sequence of acts that enable  $a(i,t_1)$  to change into  $a(i,t_2)$  (known);

Let  $D(i,t)$  indicate the set of Goals which  $a(i,t)$  want at time  $t$  to achieve at sometime  $t_2$  ( $t \leq t_2$ ), then:

$D(i,t) = (a(i,t_1)Ws(i, t_1, t_2)a(i,t_2)) * ,$  in which:

$(t_1 \leq t \leq t_2)$  or  $(t \leq t_1 \leq t_2)$ ,

$Ws(i, t_1, t_2)$  is a sequence of acts that enable  $a(i,t_1)$  to change into  $a(i,t_2)$  (unknown);

Let  $W(i,t)$  indicate the set of Plans which  $a(i,t)$  is able to do at time  $t$ ,

$W(i,t) = (a(i,t)Ws(i, t, t_2)a(i,t_2)) * ,$  in which:

$t < t_2$ ,

$Ws(i, t, t_2)$  is a sequence of acts that enable  $a(i,t)$  to change into  $a(i,t_2)$  (try to do);

**Definition 8. Transmigration**

Transmigration indicates the inner-mechanism which enable the state of  $a(i,t)$  transform:

while(true)

{ while( $W(i,t) \neq \text{NULL}$ )

{ do  $W(i,t)$ ;

modify  $CA(i,t), AA(i,t), OA(i,t), H(i,t), D(i,t), W(i,t),$

$RAAA(i,t), RAOO(i,t), RAAO(i,t), RAOA(i,t)$ ;

Let  $a(i,t)$  change into  $a(i,t+\Delta t)$

};

if ( $D(i,t+\Delta t) \neq \text{NULL}$ )

then{ if ( $a(i,t+\Delta t)$  may produce  $W(i,t+\Delta t)$ )

then produce  $W(i,t+\Delta t)$

else ask some  $U\_agent$  for advice;

}

}

\* indicates duplication,  $U\_agent$  indicates a user.

**Characteristics of AORBCO and Relation with Other Researches**

**Unity of Static and Dynamic.** The static relations among elements in the digital world are described with  $DW(t)$ , the relationship between the digital world and the reality world are described with ( $WRD(i,t), WDR(i,t)$ ), and the inner-mechanism of state conversion in every  $a(i,t)$  is described with Transmigration, which integrate the static provisionally and the dynamic variability and supply a study platform for open logic, modal logic, case-based learning, sequence-based learning<sup>[12]</sup> and situation calculus. The variability means the variety of element numbers (the structure) and the variety of relations among elements.

**Unity of Whole and Its Elements.** The digital world is described with relations among its elements and an element is described with its relations with others, which reflect the common relationship among things. Isomorphism of the whole and the parts makes the digital world to be analyzed and designed easily and supplies a study platform for MAS, ontology and commonsense.

**Unity of Accuracy and Fuzziness.** The relations among elements in the digital world are described with ( $Id, Ra, Rr, Ri$ ) \* which gives consideration to both qualitative methods and quantitative methods, which supplies a study platform for symbolic learning, statistical learning[18], fuzzy logic, neural networks and Bayesian networks.

**Unity of Syntax and Semantics.** An element is described with the relations with other elements, that is, the relations between one element and others are the syntax structure of the element and are also the semantic explication of the element, or say with other words, the meaning of an element is the sum total of relations between itself and others, so the method integrates the form and content of elements, which makes reasoning in the digital world easily and supplies a study platform for ontology, semantic WEB and natural language understanding<sup>[19]</sup>.

**Unity of Image and Abstraction.** The elements and the classes of elements are represented with unified form, the difference between them is incarnated in the relations between them, which make the knowledge to be expressed and processed easily, and supply a study platform for thinking in images, comprehensive reasoning, the consistency and perfection of knowledge.

**Unity of Parallel and Serial.** The state evolution of an agent is serial and the state evolution among agents is parallel, generally the state evolution of the digital world is serial as well, which supply a study platform for MAS and the grid computing [20].

**Unity of Passive and Initiative.** Controlled by the environment the digital world or an agent is passive and is also initiative because of the inner-mechanism. The initiative property indicates aim-guidance and planning mainly and supplies a study platform for MAS and CP [17].

## **Conclusions**

The digital world is a part of the reality world and is also the manifesting of the seeds stored in the eighth consciousness. It is a formalized partial map of the structure of human mind and also is an organic set of computers and information stored in and processed with computers. The computer technology will be limited within the digital world. AORBCO model, a formalized model that the digital world is described with, is a theoretical basis for integrating the models used in AI and making computers more intelligent. AORBCO is a theoretical model so there are a lot of works to be done for its practical application:

- 1) To study the methods and tools for analyzing and designing systems based on AORBCO and set up the methodology based on AORBCO.
- 2) To develop the language and the environment based on AORBCO for system development.
- 3) To popularize the methodology and the environment based on AORBCO to develop more intelligent systems.

## **Acknowledgments**

This paper is supported by engineering laboratory fund projects of National Local Joint Engineering Laboratory, Special research program of Shaanxi Provincial Department of Education, Key research and development program of Shaanxi Province.

## **References**

- [1] Taixu, Faxiang-Consciousness-only Theory, the Commercial Press, China, 2002
- [2] Weiss G(ed), Multi-agent systems, A modern approach to distributed artificial intelligence, Cambridge, MA: The MIT Press, 1999
- [3] Georgeff MP, Pell B, Pollack M, Tambe M, Wooldridge M. The belief-desire-intention model of agency. In: Muller JP, Singh M, Rao A, eds. Proceedings of the 5th International Workshop on Intelligent Agents V: Agent Theories, Architectures, and Languages (ATAL'98). Paris: Springer-Verlag, 1999. 1~10.
- [4] Rao AS, Georgeff MP. Decision procedures of BDI logics. Journal of Logic and Computation, 1998, 8(3):293~344.
- [5] Wooldridge MJ, Jennings NR. Intelligent Agent: Theory and practice. Knowledge Engineering Review, 1995, 10(2):115~152.
- [6] Busetta P, Rönquist R, Hodgson A, Lucas A. Jack intelligent Agents: Components for intelligent Agents in Java. Technical Report, Agent Oriented Software (AOS) Pty Ltd., 2001. <http://www.agent-software.co.uk/shared/home/index.html>.
- [7] Hindriks Koen V, de Boer Frank S, van der Hoek Wiebe, Meyer John-Jules Ch, Agent programming with Declarative Goals, 2000, <http://citeseer.nj.nec.com/hindriks00agent.html>

- [8] Yoav Shoham, Agent-oriented programming, *artificial intelligence*,60:51-92,1993
- [9] Diana Y. Paul, the Structure of Consciousness in Paramaartha's Purpoyted Trilogy, *Philosophy East and West*, 1981, 31(3):297~319
- [10]Pan Yun-he and Geng Wei-dong, Reasoning with Images, In: Lu Ru-cen(ed) *Knowledge Engineering and Knowledge Science at the Beginning of 21st Century*, 109-116,Tsinghua University Press, Beijing, 2001
- [11]Georgeff MP, Pell B, Pollack M, Tambe M, Wooldridge M, The belief-desire-intention model of agency. In: Muller JP, Singh M, Rao A, eds. *Proceedings of the 5th International Workshop on Intelligent Agents V: Agent Theories, Architectures, and Languages (ATAL'98)*. Paris: Springer-Verlag, 1999, 1~10.
- [12][12] Sun R and Giles L, *Sequence Learning: Paradigms, Algorithms and Applications*, Springer-Verlag, 2000
- [13][13] Guarino N., Formal ontology and information systems, In: Guarino N.(ed.) *Formal Ontology in Information Systems*, 3-15. ISO Press, 1998
- [14]Smith, B., Formal Ontology, Commonsense and Cognitive Science, *International Journal of Human-Computer Studies*, 43,641-667, 1995
- [15]Hendler James. Agents and the Semantic Web, *IEEE Intelligent Systems*, March/April,2001
- [16]Anthony M. Probabilistic Analysis of Learning in Artificial Neural Networks: The PAC Model and Its Variants. *Neural Computing Surveys*,1997,1:1-47
- [17]Freuder G. And Wallace Mark. Interview: Constraint technology and the commercial world, *IEEE Expert Intelligent Systems & Their Application*, 2000, 15(1):21-23
- [18]Vapnik, V. *Statistical Learning Theory*, Addison-Wisley, 1998
- [19]Lillian Jane Lee. Similarity-based Approaches to Natural Language Processing, Ph. D thesis, Harvard University, cmp-lg/9708011, May,1997
- [20]Gabrielle Allen, Thomas Dramlitsch, Ian Foster, Nick Karonis, Matei Ripeanu, Ed Seidel, Brian Toonen. *Supporting Efficient Execution in Heterogeneous Distributed Computing Environments with Cactus and Globus*, Supercomputing 2001.
- [21]Thad Starner, Bernt Schiele, and Alex Pentland, *Visual Contextual Awareness in Wearable Computing*, IEEE ISWC '98
- [22]Li W. and MA S., A Framework for Analytic-Intelligent Agents, *Proceedings of the International Conference on Artificial Intelligence*, Las Vegas, USA, June 26-29,2000,CSREA Press,691-697
- [23]Wallen L. *Automated proof search in non-classical logics*, MIT Press, Cambridge, Massachusetts, 1990
- [24]David B. Leake, Larry Birnbaum, Cameron Marlow, and Hao Yang, *Integrating Information Resources: A Case Study of Engineering Design Support*, In: *Proceedings of the Third International Conference on Case-Based Reasoning, ICCBR-99*, Springer-Verlag, Berlin. 1999
- [25]Nir Friedman, Iftach Nachman and Dana Pe'er, *Learning Bayesian Network Structure From Massive Datasets: The "Sparse Candidate" Algorithm*. *Proceedings of the Fifteenth Conference on Uncertainty in Artificial Intelligence*, Morgan Kaufmann Publishers, Inc., San Francisco, 1999
- [26]He Xin-gui, *Fuzzy Reasoning Networks and Computing Reasoning*, *Chinese Journal of Software*, 1996, (10):282-287