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Research on AORBCO Model and Its Description Language

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***Abstract*—This paper improves the AORBCO model based on the four characteristics of intelligence- self conscious, mutual representation, fuzziness and dynamics, and designs a description language of AORBCO model. The language describes the self-consciousness with its five components-belief, desire, ability, planning and behavior control mechanism. The components of entities including acquaintances of an agent and objects known by the agent are as the starting point to characterize the mutual representation of intelligence. Introducing and updating of the weights to express the closely degree of relationship among entities are to simulate the fuzzy of intelligence. The behavior control mechanism of the agent makes the intelligent dynamics realization. The AORBCO description language based on XML makes the expression form and content of the resources unify through the definition of correlative marks, which is convenient for people and computers to understand the semantics of language components. The essence of space and time is also revealed in this paper.**

Keywords-AORBCO; Intelligent Mode; Agent; Self-consciousness; Description Language

I. INTRODUCTION

The AORBCO model was proposed in the literature[1]. Its purpose is to unify the concepts of ontology in philosophy and computer science so that the expression form and content of the resources are combined organically. In the literature[2], the author try to unified the intelligent models of the three schools of artificial intelligence as an integrated intelligent model. However, through the study of literature[3, 4 and 5], it is known that intelligence not only has the characteristics of mutual representation, fuzziness and dynamism but also more self-awareness. The concept of ontology in philosophy refers to the origin of things, the origin is invisible and incomprehensible, and everything is just the manifestation of ontology[6] . People in computer science field uses the concept of ontology to formally define the terms used in a certain field and their relationship[7]. It is actually just a formal definition of domain knowledge only. Therefore, we think it is better not to use the concept of domain knowledge in the field of computer science, but rather to ensure the sacredness of the concept of ontology in philosophy and better understand the connotation and relationship of related concepts in computer science.

Based on the above research, especially with the improvement of the original AORBCO model based on the intelligent self-awareness, this paper proposes AORBCO intelligent model with agent as the core, simulates human's thoughts and behaviors , and makes the agent imitate human's behavior model to deal with the information in order to achieve the automatic update and evolution of knowledge to make the agent more intelligent. At the same time, the AORBCO description language is designed for the model, and its description form and language structure are more in line with the new AORBCO intelligent model[8,9] expression needs..

II. A FORMAL DESCRIPTION OF AORBCO

In our real life, human beings seem to live in the same world, but if you analysis carefully you can find that each person is an independent individual and has a different worldview. Each people are individuals observe from your own perspective. For each individual, the world exists in his own understanding, and it is impossible for an individual to jump out of his field of vision to see other people's "world". This is what people often say the "one person, one world". Individuals in the observing the surrounding environment and communicating with other individuals at the same time, in this process we will modify our own understanding of the concepts and its relationship, and then through self-understanding to form new ideas or new abilities; in many individual exchanges and communication we will build a common view of things and awareness, that is, domain knowledge - knowledge system based on consensus[10]. We want to simulate this process of knowledge formation and updating in the computer world, simulating human intelligence through an agent in the AORBCO intelligent model, which consists of five components of belief, desire, ability, planning, and behavior control mechanisms, Defined as follows:

Definition 1: Subject, agent

Assume: a(t) denote the agent's cognition of its own state at time t, Aa represents the set of acquaintances recognized by the agent; Oa represents the set of objects known by the agent; Ra represents the set of relations recognized by the agent; H (t) represents the set of work completed by the agent before time t，namely the historical operation set of agent; D (t) represents the agent's desire at time t; P (t) represents the set of work to be done at time t, namely, the plan of agent to realize the current wish; behavior_controller represents the agent's behavior control mechanism;

a(t)=(Aa, Oa, Ra, H(t), D(t), P(t), behavior_controller)

t is what we usually say time, its essence is the order of the agent in different states (that is, what we call the space) .

Definition 2: Acquaintance subject, acq-agent

Assume: aa (i, t) denote the agent's cognition of acquaintance subject's state at time t, aa(i, t) ⊂Aa. "i" represents the name or number of the subject of an acquaintance, especially the subject of an acquaintance. Aaa represents a acquaintance subject's(acq-agent.i) acquaintance set; Oaa represents a set of objects known by acq-agent. i; Raa represents a set of relations perceived by acq-agent.i; H(i, t) represents a set of work to be done before time t,namely the historical operation set of acq-agent. i; D(i, t) denotes the desire of acq-agent. i at time t; P(i, t) denotes the set of actions to be performed by acq-agent. i at time t, namely, the plan of acq-agent. i to realize the current wish; Then:

aa(I, t)=(Aaa, Oaa, Raa, H(I, t), D(I, t), P(I, t))

he description of Aaa, Oaa, Raa, H(i, t), D(i, t), P(i, t) correspond to Aa, Oa, Ra, H(t), D(t) and P(t) in agent respectively, their formal definition is similar too.

Definition 3: Object, object

Assume: o (i, t) represents the state of the object (object.i) which the agent knows at time t, o (i, t) ⊂Oa. Oo represents the set of objects related to object. i in the agent's cognition, Oo⊆Oa; Ao represents the set of agents which are related to object. i, Ao⊆ Aa; Ro represents the set of relations related to object. i , Ro⊆Ra.

o(i, t)=(Ao, Oo, Ro)

Definition 4: Relationship, Ra

Assume: R (ei, ej, t) represents the cognition of the subject at time t,R(ei, ej, t)∈Ra;e_i, e_j denotes agent or object, and Id is the relationship name; ra represent the degree of closeness, the value range [0,1]; ri represent instantaneous relationship, the value is 0 or 1; ra = Σri / t. Then:

Ra(e_i, e_j, t)=(Id, ri, ra)，if ri is 0, e_i, e_j has no relationship named Id at time t; if Ra(e_i, e_j, t) is empty, e_i and e_j have no relationship.

Definition 5: History, H(t)

Assume:Work means the operation or sequence of operations that subject has performed. Then:

a(t1) Work a(t2)∈H(t)，t1<t2<t

a (t1) Work a (t2) represent the agent is from the state a (t1) to state a (t2) by executing the action.

Definition 6: Desire, D(t)

Assume: Work represent a operation or a operation sequence that subject planed to achieve the desired.Then:

a(t1) Work a(t2)∈D(t)，t<t1<t2 或 t1<t<t2

Definition 7: Plan, P(t)

Assume: Work indicates the sequence of actions or operations to be performed by subject. Then:

a(t) Work a(t1)∈P(t)，t<t1

Definition 8: Behavior control mechanism, BC

U-agent indicates the user body or user, then BC could be described like this:

```
t=t0;
Initialize a(t0);
While(D(t)≠null)
{
If (a(t)could generate W(t)) {
Generate P(t) and execute it;
   t=t+δt;
}
else  consult U-agent;
}
```

III. DEFINITION OF AORBCO DESCRIPTION LANGUAGE

In order to make the AORBCO model practical, the BNF definition of its description language is given. In this description language ,type is used to represent types, which are basic data types and user-defined classes; val represents an object itself; weight represents a number between (0,1); suffixes with _name are Identifier; and define these keywords: agent, Belief, Act, Desire, Plan, behavior_controller, acq_Agent, acq_Object, acq_Class, acq_Bbelief, acq_Aact, acq_Ddesire, acq_Pplan, address, acq_Aagent, acq_Oobject, acq_Cclass, member ship formula, precondition, post condition, parameter (the keyword in the definition is in bold.), Arguments, its semantics will be introduced in the fourth part.

TABLE I. THE SYMBOLS USED IN BNF DEFINITIONS ARE AS FOLLOWS

symbols	Definitions
:: =	"defined as" meaning
[ ]	there are optional
{}	there is a collection
|	the content on the left and right sides is optional
Terminator	in bold
Non-terminal	in normal fonts

- subject::=<agent agent_name> BeliefSet AbilitySet DesireSet PlanSet BehaviorControl </agent agent_name>

- BeliefSet::=<Belief [/] >[AcquaintanceSubjectSet
- CognitiveObjectSet CognitiveClassSet</Belief>]
- AbilitySet::=<Act [/] > [{Ability}</Act>]
- DesireSet::=<Desire [/] >[{Desire} </Desire>]
- PlanSet::=<Plan [/] > [{Plan} </Plan>]
- BehaviorControl::=<behavior_controller>ControlFunction</behavior_controller>
- AcquaintanceSubjectSet::=<acq_Agent [/]>[{AcquaintanceSubject}</acq_Agent>]
- AcquaintanceSubject::=<agent_name>
- weight AcquaintanceBeliefSet AcquaintanceAbilitySet AcquaintanceDesireSet AcquaintancePlanSet CommunicationInterface</agent_name>
- CognitiveObjectSet ::=<acq_Object [/]>[{Object}</acq_Object>]
- Object::=<object_name> {ObjectAttributes}</object_name>
- CognitiveClassSet::=<acq_Class [/]>[{Class}</acq_Class>]
- Class::=<class_name>weight {ClassAttributes} MembershipCalculationFormula</class_name>
- Ability::=<action_name [/] >[Precondition Postcondition ParameterList
- actionBody</action_name >]
- Desire::= <desire_name [/]>
- [LogicExpression</desire_name >]
- Plan::=<desire_name [/]>
- [{<action_name>ArgumentList</action_name>} </desire_name>]
- AcquaintanceBeliefSet::=<acq_Bbelief[/] >[Subject SetOfAcquaintance
- ObjectSetOfAcquaintance
- ClassSetOfAcquaintance
- </acq_Bbelief>]
- AcquaintanceAbilitySet::= <acq_Aact [/] >[{AcquaintanceAbility}</acq_Aact>]
- AcquaintanceDesireSet::=<acq_Ddesire [/] > [{Desire} </acq_Ddesire>]
- AcquaintancePlanSet::=<acq_Pplan [/] > [{Plan}</acq_Pplan>]
- CommunicationInterface::=<address URI/>
- SubjectSetOfAcquaintance:=<acq_Aagent [/]>[{<agent_name/>}</acq_Aagent>]
- ObjectSetOfAcquaintance::=<acq_Oobject [/]>[<object_name/>}</acq_Oobject>]
- ClassSetOfAcquaintance::=<acq_Cclass [/]>[{<class_name/>}</acq_Cclass>]
- AcquaintanceAbility::=<action_name [/] >[Precondition Postcondition ParameterList</action_name>]
- ObjectAttributes::=< attr_name >type:val;weight</attr_name>
- ClassAttributes::=<attr_name> type: weight </attr_name>
- MembershipCalculationFormula::=
- <membershipformula>
- FunctionExpression
- </membershipformula>
- Precondition::=<precondition> LogicExpression </precondition>
- Postcondition::=<postcondition> LogicExpression </postcondition>
- ParameterList::=<parameter [/] > [{parameter_name : type;} </parameter>]
- ArgumentList::=<arguments [/] > [{arguement_name : val;} </arguments>]
- ActBody::=<body>Function</body>

IV. THE CONNOTATION OF THE AORBCO DESCRIPTION LANGUAGE

The AORBCO Description Language describes the AORBCO Intelligence Model in a way that unified expression of content and form (semantics and grammar), which intent to define the language components that both humans and computers can understand. Mutual Representation is one of the characteristics of intelligent systems, that is, anything describes itself through the relationship with other things. The AORBCO description language uses the syntax of XML with the form:<tag>...< / tag> , that is ,the label's semantics are defined by its component "...", and its components may have other labels in turn, so that the system has an intelligent mutual representation, it shows the complex relationship between the concept. Fuzziness is another characteristic of the intelligent system, that is, the degree of the closeness of the relations among things is different. The AORBCO description language is explicitly represented by the weight. In addition, the description of the acquaintance of the subject and the acquaintance of the acquaintance in the model is difference in detail. It is also an implicit expression of fuzziness. Evolution refers to subject in the system adjust constantly the relationship between subject and object. The mutual representation of things is the premise of fuzziness, and the fuzziness changes with the operation of the system, so that the whole model is in an evolving dynamic.

A. Description of the agent

AORBCO model is based on the idea of "one person, one world" to build a self-aware intelligent model centered on the agent. Through the analysis of the composition of human self-awareness [13], we divide the agent into five parts: Belief, Act, Desire, Plan, behavior_controller.

Belief is the agent's description of the entity it knows and entities' relationship. We hope to express the "worldview" that the agent possesses through belief, that is to say, agent's view of the world. Ability means the function that an agent can do. Desire is the target state they hope to achieve. Planning is an ordered set of capabilities that are chosen to fulfill their desire. Behavior control mechanisms enable the above components to form an organic whole. The description of the agent is as follows:

<agent name>
<Belief/>
<Act/>

```
<Desire/>
<Plan/>
< behavior_controller />
</agent name>
```

B. Description of the belief

Belief is description of the entity agent knows and its relationship. Entities are divided into two categories: one is subject, an active acquaintance principal; another is a passive object. There are two kinds of relationship between entities. The description of the belief is shown below:

```
<Belief>
   <acq_Agent/>
   <acq_Object/>
   <acq_Class/>
</Belief>
```

1) description of the acquaintance subject

<acq_Agent /> represents an acquaintance subject set, which is the mapping of other subjects that are related to the agent.Acquaintance subject have their own beliefs <acq_Bbelief/>, abilities <acq_Aact />, wishes <acq_Ddesire/>, planning <acq_Pplan/>, which are not described in detail,expect the mechanism of behavior control. In addition, the acquaintance also added the communication interface <address />, using URI as the only one address identifier. Each agent have a special subject of acquaintance, that is, himself. In the acquaintance's belief, using <acq_Aagent/>, <acq_Oobject/> and <acq_Cclass/> describe the acquaintance subject's acquaintance, objects and classes. The specific form is as follows:

```
<acq_Agent>
   <agent_name>
      weight
      <acq_Bbelief>
         <acq_Aagent/>
         <acq_Oobject/>
         <acq_Cclass/>
      </acq_Bbelief>
      <acq_Aact/>
      <acq_Ddesire/>
      <acq_Pplan />
      <address URI/>
   </agent_name>
   ……
<acq_Agent>
```

weight refers to the degree of intimacy between acquaintance subject and agent.

2) description of the object

<acq_Object/> represents the set of objects that the agent knows, and <object_name/> represents an object in the set of objects and consists of the attributes of the object. Object attributes are other objects related to this object; object attributes is composed of the object attribute name <attr_name/>, the attribute type, the attribute value and weight. In fact, the external form of the subject exists in the form of the object, which is called the subjectivity of the subject. To represent the subjectivity of the subject, a special kind of object is designed to describe the characteristics of the corresponding subject, which represent the subjective perception of the object or an acquaintance. The specific description of the object is as follows:

```
<acq_Object>
   <object_name>
      <attr_name>type:val;weight</attr_name>
      .....
   </object_name>
   .....
</acq_Object>
```

3) description of the class

In this paper, the model is divided into specific and abstract relationship, the specific relationship is reflected in the description of each element.

Described in <acq_Class/> is the abstract relationship, which is the subject of object classification, including two: One is the agent's classification of the object it currently knows; the other is the agent's classification of acquaintances it knows. The classification of the acquaintance subject is based on the subject's objectivity mentioned above, so we use the same description of the object class here. Each class include 4 parts: class name <class_name/>, class attribute list, class membership calculation formula <membershipformula/>, and membership threshold weight. The class attribute indicates characteristics which the object belong to this class should have, including attribute name <attr_name />, data type and weight (weights and thresholds are expressed in weight)which means how important this attribute is in the class. The class membership degree calculation formula is based on the class attribute features to calculate the degree of object belonging to the class, the value range (0,1), membership threshold is used to specify the minimum membership value belongs to the class. The specific description is as follows:

```
<acq_Class>
   <class_name>
      <attr_name> type:weight </attr_name>
      ……
      <membershipformula/>
      weight
   </class_name>
   ……
</acq_Class>
```

C. Description of the ability

<Act /> here represents the set of capabilities of the agent, including several specific capabilities. Each act consists of capability name </action_name>, precondition </ precondition >, post-condition </postcondition>, formal parameter list <parameter /> and action body <body />. The precondition indicates the condition that the parameters related to the action should satisfy before the action is executed. The post-condition indicates the condition that the parameter related to the action should satisfy after the action is executed. The action body is a specific execution process. The specific description of the ability is as follows:

```
<Act>
   <action_name>
      <precondition/>
```

```
    <postcondition/>
    <parameter/>
    <body/>
  </action_name>
  ……
</Act >
```

D. Description of the desire

<Desire /> indicates that the target state set of the agent contains a number of specific wishes, which is the main motivation of the agent's behavior. <desire_name/> represents one of the wishes that represent the state the agent wants to reach or maintain. These aspirations may be user agent commands or requests from other agents, or the distance between changes in the environment and hold. The realization of the wish is to make the corresponding plan through the planning function in the behavior control mechanism. During the execution of these plans, there may be changes in belief or ability to achieve the desired goal. A detailed description of the wishes is as follows:

```
<Desire>
   <desire_name/>
……
</Desire>
```

E. Description of the plan

<Plan /> is the best set of action sequences that the agent can make at present according to the agent's ability. Each plan consists of a desire name <desire_name/> and an action list, each composed of <action name> and an actual argument list <arguments />. <desire_name/> represents a plan for desire. The detailed description of the plan is as follows:

```
<Plan>
    <desire_name>
    <action_name>
    <arguments/>
    </action_name>
     ......
    </desire_name>
.....
</Plan>
```

F. Description of the behavior control mechanism

<behavior_controller/> is the behavioral control mechanism of agent. It modifies its own beliefs and forms a wish through the perception of the environment, which is planned and implemented by the desire, according to its own ability or through interaction with acquaintances. In the process of implementation, it modify its beliefs and abilities and organize the other parts to make agents self-aware.

V. CONCLUSION

In this paper, the original AORBCO model is improved to form a new AORBCO intelligent model with agent as the core, which can describe intelligent self-awareness, mutual representation, fuzziness and dynamics more accurately; Based on XML, the definition language of AORBCO intelligent model is defined so that the expression content and form of resources are unified so that people and computers can understand the semantics of language components. The behavior control mechanism in AORBCO model integrates the agent's beliefs, abilities, wishes and programs into one. It is the core of simulating human self-learning, interaction and collaboration, planning decision-making and execution control. It will become the focus of our research in the future.

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