U.P.B. Sci. Bull., Series C, Vol. 86, Iss. 3, 2024 ISSN 2286-3540

A TRUST MODEL AND EVALUATION MECHANISM BASED ON ARTIFACT FOR COMPOSITE SERVICE

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Composite Service contains complex business logic and data interaction, the construction of trust model is restricted by the business process model. While the traditional process-centered business process modeling method can't reflect the importance of key business data in business processes, it's difficult to evaluate service's trust value from the perspective of business areas. This paper discusses this problem, a business case of course teaching service is given first, then a data-centric business process modeling method is introduced by combining this case, finally implement a verification of prediction accuracy of this trust evaluation mechanism through an experiment.

Keywords: Artifact; Composite Service; Trust Model; Trust Evaluation; Bayesian network

1. Introduction

With continuous deepening of Service-Oriented Architecture (SOA) idea and rapid application of new technologies in IT field like software as a service (SaaS) and cloud computing, Web service has gradually developed from simple function encapsulation towards the intelligent direction, it is more reflected as composite services (larger-granularity services) constituted by multiple component services(small-granularity services) with unitary function and simple structure, and finally reflected as complicated business process and data interaction inside service portfolio.

In the service trust field, although trust issue of Web service has gradually become a research focus, trust research work oriented for composite services is still in tentative exploration stage. Compared with traditional modes, trust problems become more serious and crucial in composite services because of the nontransparency and short-term cooperation mode between component services. The existing main difficulties lie in the following: the inside service portfolio has integrated a large amount of basic service units and contained complicated service logic and data interaction, and trust evaluation of service portfolio is based and

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restricted by models of business process of service portfolios. While most traditional service portfolios implement configuration of component services based on workflow models, and this modeling method which “focuses on process” can’t embody significance of key business data in business process, it’s very hard to embody different requirements for trust evaluation of service objects in the specific business field [1-4].

In the business process field, in recent years, after Nigam, Caswell (2003) suggested concept of Artifact [5], business process modeling technologies that “focus on data” have gradually sprung up. While implementing business process modeling, firstly confirm key data entity (Artifact) that promotes development of business process, then conduct modeling and analysis of business process by moving around variation of data entity (Artifact) in business process. This kind of business process modeling idea provides powerful support for trust evaluation of service portfolio and has obvious advantages in flexibility and customizability of service presentation and system implementation, thus making it possible for conducting fine trust evaluation for composite services by moving around specific data objects and service objects.

This paper introduces Artifact idea into business process modeling of composite services and suggests a kind of trust evaluation and prediction method based on business process. Firstly, give a business case of course teaching, then give relevant definitions of business model and trust model of composite services based on Artifact and conduct a specific explanation by combining business cases, then suggest a trust evaluation mechanism based on data-centric business process, finally implement a verification of prediction accuracy of this trust evaluation mechanism through an experiment.

2 Related Work

2.1 Trust Research Oriented for Composite Services

In recent years, based on achievements in atomic-scale Web trust research field, some scholars have started research studies on trust evaluation and prediction mechanism of larger-granularity services (i.e. composite services). A composite service trust evaluation method was proposed based on service orchestration patterns [6], and this method conducts trust integration of atomic services mainly based on execution path and probability of business process. A composite service trust evaluation method was proposed based on Bayesian network [7], which uses Bayesian network to capture relationship between atomic services and obtain reliability of composite services by comprehensively calculating reliabilities of trust nodes in different aspects. A trust evaluation method for service composition in cloud manufacturing is proposed [8], the trust of service composition depends on the trust values of all component services and the correlations between them. A calculating method through a trusted graph was provided [9], which focused on graph-based trust evaluation models in Online Social Networks. A trustworthy Web service composition and optimization framework called TWSCO was proposed to guarantee the trust of composite service and efficiency of Web service composition process [10].On the whole, trust research work oriented for composite services is still in tentative exploration stage, most research studies conduct trust evaluation from the angle of traditional QoS of service performance, not being able to meet relevant requirements for trust evaluation from the angle of business field.

2.2 Business Process Modeling Work "Focuses on Data"

In recent years, business process modeling idea has transferred from "focus on process" to "focus on data". Modeling idea of "focus on data" derives from Artifact concept put forward by Nigam et al. (2003) from IBM, they defined Artifact as specific, identifiable and self-descriptive message blocks in the process, and it contains all messages required for completing a process. Artifact has encapsulated relevant data objects and their life cycles of the business and recorded what component services (tasks) triggered state transition of data objects.

After IBM gave the concept of Artifact, there have been many relevant research studies and applications in recent years. Reference [11] introduced ACEL (Artifact-Centric Event Log), an extension to the OCEL (Object-Centric Event Log) standard, specifically designed for artifact-centric processes [11]. Reference [12] propose a configurable modeling framework, especially for artifact-centric business processes. The artifact-centric process models can be derived by configuration based on the behavior of a configurable model [12]. References from [13] to [15], directing at complicated business environment of mutual behavioral interaction between multiple Artifacts, conducted a series of research studies on composite Artifact modeling from angles like behavioral consistency and synchronized reliance [13-15]. Reference 16 used UML activity diagrams with object flows as data-centric process modeling notation, showed how the resulting object-centric designs can be mapped to declarative, artifact-centric schemas [16]. References from [17] to [18] suggested a business process conceptual model based on Artifact and launched a series of research studies on effectiveness issues in the business process of Artifact [17-18]. Reference [19] captured the information required for the complete execution and reasoning of a business process by relying on the expressive power of an artifact-centric specification [19], which combines UML state and activity diagrams. Reference [20] studied realization requirements for the flexible enactment of artifact-centric business processes in a dynamic, collaborative environment and developed a workflow execution framework that can effectively address those requirements [20].These research studies have obtained good achievements in terms of formalized definition, behavioral interaction, data capturing and process modeling and so on of Artifact, presenting obvious advantages in flexibility and customizability of service presentation and system implementation. This business process modeling idea which "focuses on data" puts forward a brand-new solution for trust evaluation of service portfolios, thus making it possible for conducting fine and customized trust evaluation surrounding specific data objects and service objects.

3 Business Cases

In order to conduct model definition and explanation in a more intuitive way, we firstly give a typical application scene of composite services.

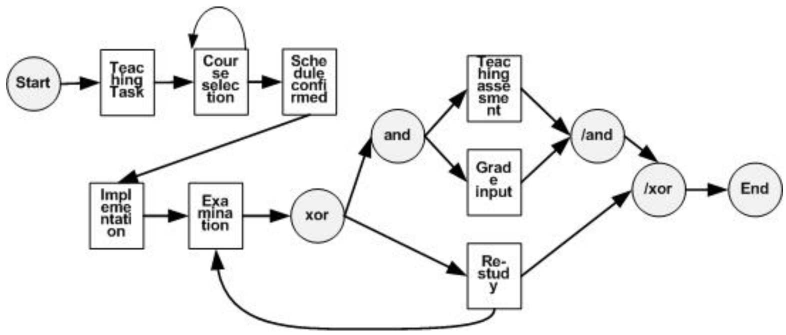

Fig. 1. Digraph Presenting Course Teaching Service

Educational management system is core business system of colleges and universities, we select course teaching service as research object of composite services, including component services (atomic services) like teaching task assignment, students course selecting, course schedule arrangement, course assessment and students' teaching evaluation, involving multiple business objects such as teachers, students, classes and departments, and there are complicated business process and data interaction between services. The digraph of this service we give is as shown in Fig. 1.

Square nodes in Fig. 1 are used to represent component services, circular nodes represent process control, full-line sides represent logic reliance, starting points of sides are relied on components and terminal points of sides represent relying on components, this digraph can clearly represent internal business process of the whole composite service but it can't fully represent interaction and transition status of business data in the process.

4. Business Model and Trust Model of Composite Services Based on Artifact

4.1 Business Model

The composite service has integrated a large amount of basic component services and contained complicated business logic and data interaction, so it's very suitable for application of research achievements of existing Artifact. Relevant definitions of its business model are given as following:

Definition 1: Artifact-Centric Process Model for Composite Service, ACPM-CS. We use a triple-tuple (Z,T,R) to express it, where:

— Z={Z_1,Z_2,…,Z_n}, $Z_i (1 \le i \le n)$ is a Artifact class associated with this service;

— T={t_1,t_2,…,t_m}, $t_i (1 \le i \le m)$ is a task for reading or writing operations in Artifact business data, usually corresponding to one or more atomic services in composite service;

— R={r_i,r_2,…,r_k}, $r_i (1 \le i \le k)$is a business rule which trigger data interaction and Artifact state transition.

Definition 2: Artifact Class. An artifact class abstracts a group of artifacts with their data attribute and states. An artifact class C is a tuple (A, S) where:

— A={a_1,a_2,…,a_n}, $a_i (1 \le i \le n)$ is an attribute of a data attribute;

— S={s_1,s_2,…,s_m}, $s_i (1 \le i \le m)$ is a state.

Definition 3: Artifact instance. Given artifact class C, we use a four tuple(id,C,a,s) to express one operate instance of this class, id is a unique identifier, s is current state, a={a_1,a_2,...,a_n} denote each data attribute's value of current state.

Take course teaching service described in section 3 as an example, in business flow of its internal atomic services, it mainly involves data write-read operations of teaching task, learning record and teaching record, and these operations happen in different business processes. We encapsulate relevant business data and business status, define three Artifact types, and relevant structure is as shown in Fig. 2. Different from business process digraph in Fig. 1, as business data is encapsulated in Artifact, it can effectively record interaction and transition status of business data in business flow process.

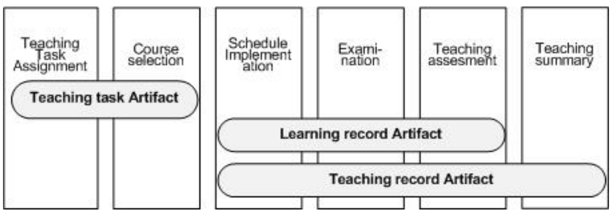

Fig. 2. Artifact Structure Chart Representing Course Teaching Service

In Fig. 2, teaching task is a typical artifact class, deifined as R(A,S)=((teaching task ID, course ID, teacher ID, time ID, class scale, course selection rate), (create, cancel, execute, finish)), a teaching task assigned in a semester is an Artifact, and it can be expressed as r(id,z,a,s)=(201511001,R,(2015001,001,001,201501,100,85%),(execution)).

In order to express data interaction and state transition of Artifact more clearly, give further definition of business rules based on Definition 1.

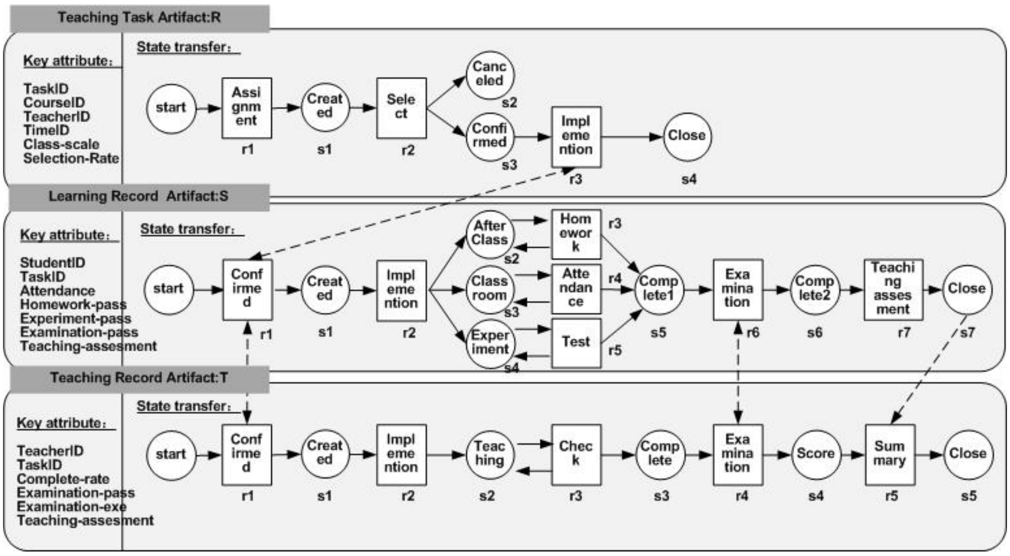

Fig. 3. Artifact Business Model Representing Course Teaching Service

Definition 4: Business rules. They are specific descriptions of internal business logic of composite service and they are expressed by a triple (λ,β,T). T is data write-read task (usually corresponding to one or multiple atomic services) triggered by the rule at this time, λ and β are respectively precondition and post-condition (represent input data and output data of this business rule)that trigger the rule at this time.

Business rules not only represent business process of atomic services of composite service but also make an appointment for triggering conditions and interaction results of data interaction between atomic services. We further give Artifact business model of course teaching service as shown in Fig. 3. In Fig. 3, we define service attributes of three Artifact types: teaching task R, learning record S and teaching record T and describe business state and state transition by using Petri network. In state transition graph, each place represents a business state of Artifact, and transition represents a business rule. Taking teaching task R as an example, we give definition of its business rule as shown in Table 1.

Table 1

Definition of Artifact-Type Business Rules of Teaching Task

Rule No.	Rule Name	Input Data (λ)	Output Data(β)	Trigger Atomic Service (T)	Synchronous Rule
R.r1	Teaching Task Assignment	Course ID Teacher ID	Teaching Task ID	Create Teaching Task	-
R.r2	Students' Course selection	Course Passing Rate Positive Feedback	Course Selection Rate Course	If ((course selection rate<60%)or (course enrollment<20)), cancel the	-

		of Teacher class scale	Enrollment	teaching task, else, confirm teaching task	
R.r3	Teaching Implementation	Course ID Teacher ID	Time ID	Confirm Teaching Schedule	S.r1 T.r1

In Fig. 3, use bi-directional dotted arrow to represent synchronization rules, although rules connected by two ends of the dotted line belong to different Artifacts, once one rule among them is triggered, other synchronized rules will also be triggered. Synchronization rules have established a basis of state correlation and data correlation for different Artifacts.

4.2 Trust Model

Our trust evaluation model adopts reliability to measure whether a service is trustworthy, higher reliability means trust worthier service which can more probably provide service results that meet customer’s requirements. Most existing trust evaluation models are from angle of service performance, calculating reliability by judging possibility that an individual atomic service can conform to descriptive information (including QoS indexes such as response time, stability, performance, etc.) issued on UDDI (Universal Description Discovery and Integration)registration center in actual performance, and they can’t accurately judge reliability of service quality as they are lack of correlation with business background. Hence, we give a trust model of composite services from the angle of business scope.

Definition 5: Role. It represents users with the same operations and angles of view in internal business process of composite services. It is expressed as $U=\{u_1,u_2,...,u_n\}$, $u_i(1 \leq i \leq n)$ represents a role, n is the number of roles in the current service.

Definition 6: Trust attribute. In the internal business process of composite services, value reading and variation of some business attributes may influence reliability of the whole service, and we call this attributes trust attribute. We use two-tuples (TDA, TCA) to express it, where:

— TDA is decision attribute which conducts a direct judgment of the whole service quality. It is usually evaluated by the visitor after the whole service is finished.

— TCA is condition attribute and procedural attribute which experiences valuation variation in business process. Variation of these attributes will influence valuation of one or multiple decision attributes. Most condition attributes conduct trust transitivity through logical relationships. Some condition attributes have strong trust associations, which not only affect the trust attributes of the next logical state, but also have strong trust transitivity. We call them strong condition attributes, which are represented by TCA'.

— The condition attribute TCA is used to predict and warn the decision attribute TDA, which helps to find problems in the service process in advance and take timely intervention measures to ultimately improve the service experience of users.

In a same business model, business attributes and state transition of Artifact that are concerned by different roles can be different, and obviously trust attributes will also be different. Take student role in course teaching service model, concern whether teaching service can meet his own learning requirements and give a comprehensive grade for this learning through teaching evaluation, hence, "teaching evaluation" is its trust decision attribute. By analyzing business model displayed in Fig. 3 and combining expert experience in this field, we can analyze that business attributes like "course selection rate", "attendance" and "examination performance" can be its trust condition attribute. However, about how to accurately judge trust condition attribute and measure correlation between condition attribute and decision attribute, we need to further give definitions of trust view and trust model.

Definition 7: trust view. Trust view is ergodic Artifact state and variation of trust attributes in business process of one role, trust view of role U can be expressed as $V^u=(Z^u, A^u, TDA^u, S^u, R^u)$, whereby Z^u and A^u are Artifact types and business attributes that maybe involved in business process of role U, TDA^u is trust decision attribute of role U, S^u is Artifact state that role U experiences in business process and R^u is involved business rule.

Definition 8: Artifact-Centric Process Trust Model for Composite Service,ACPTM-CS. Use a tetrad(U,Z,TDA,V) to define the model, whereby: U is role involved in the service, Z is Artifact type involved in the service, TDA represents trust decision attributes concerned by different roles, and V is trust view of different roles.

Still take student role in course teaching service model as an example, based on Artifact business model given in Fig. 3, and combining business attributes and synchronization rules confirmed in business rules as shown in Table 1, give its trust view as shown in Fig. 4.

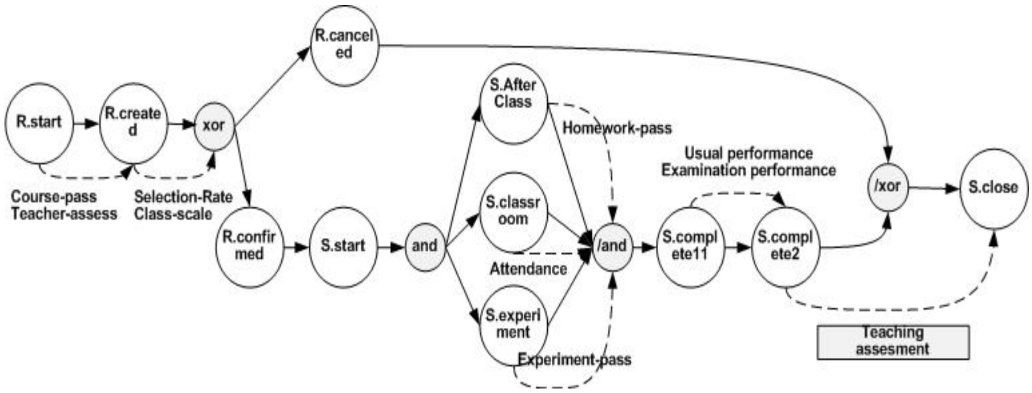

Fig. 4. Trust View of Student Role in Course Teaching Service

In Fig. 4, circular nodes represent Artifact state in which student role is involved, solid arrow represents logic dependency, dotted arrow represents data input and output in state transition, trust condition attributes are selected from business attributes that have I/O operations, student grading is trust decision attribute expressed by shading box.

5. Trust Evaluation Mechanism Based on Business Process

In actual business scenario, roles participating in internal business process of larger-granularity services are fixed, and trust decision attribute of each role can be intuitively confirmed by virtue of field experts. On the condition that Artifact business model is given, to judge whether entire service is dependable for a role, it can be converted into trust view that structures this role. According to known trust decision attributes, search for trust condition attributes in the view and conduct correlation-analysis knowledge reasoning of these attributes.

The main method of solving uncertain knowledge reasoning is Bayesian network which is also called reliability network. The network is used to represent graphical modes of connected relation probability among variables, and it provides a natural method that represents causal information to find potential relation between data. Bayesian network is a directed acyclic graph, structured by nodes representing variables and directed edges connecting these nodes, nodes represent random variables, and directed edges between nodes represent interrelation between nodes (father nodes pointing to their child nodes). The feature of Bayesian network is that: only if any node state in the network is confirmed, the network itself can use Bayesian network to implement forward or inverse calculation, thus deducting the probability of a random node in the network.

At the moment, there are many references about service trust research launched on the basis of Bayesian network. A quantitative trust assessment method was proposed based on Bayesian network [21]. Through classification of trust status of nodes, integration of trust priori probability and allocation of conditional probability, the trust probability of assessment nodes could be predicted. Reference 22 developed a new model grounded in Bayesian statistics that adopts a multiagent systems approach, employed a partially observable Markov decision process for trust modeling, moving beyond the more traditional adoption of probabilistic reasoning using beta reputation functions [22]. Reference 23 used Pi-calculus to describe composition structure and internal interaction of Bayesian trust Web service composition [23], enhancing the reliability of trust Web service composition. These research studies have obtained good achievements on application of Bayesian network in service trust field respectively from angles of composite services and field services, having good reference significance for research studies on trust evaluation mechanisms based on business process.

The following will give complete trust evaluation mechanism and conduct a specific description:

Firstly, judge roles that service objects belong to, confirm trust decision attributes and structure trust views for them, which has been specified in hereinabove 3.2;

Secondly, convert trust view into Bayesian network, confirm nodes and structure of Bayesian network by virtue of knowledge from field experts, structure prediction model of trust decision attribute, which will be specified in thereinafter 4.1;

Lastly, through sample learning, conduct parameter learning of Bayesian network, calculate reliability of each node, which will be specified in thereinafter 4.2.

5.1 Structure Bayesian Network

Trust view displayed in Fig. 4 gives logic dependency and data dependency between trust attributes. Fig. 5 is Bayesian network that conducts teaching assessment prediction and that is deducted on the basis of trust view, define each node in Bayesian network as a trust attribute, and all attributes influencing valuation of this attribute are considered as father nodes of this node. Relationship strength between attributes is expressed with condition probability, nodes without father nodes will be valuated with prior probability.

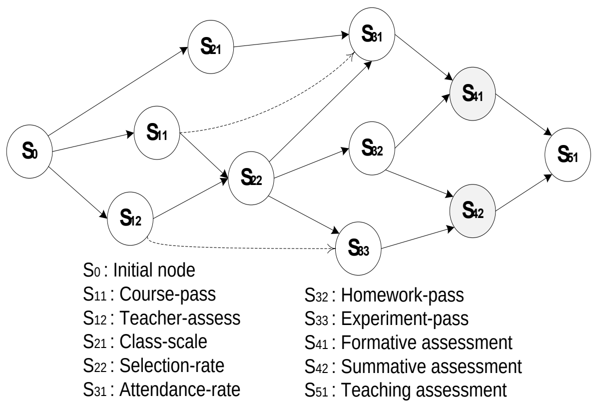

Fig. 5. Bayesian Network That Conducts teaching assesment

5.2 Calculate Reliability of Nodes

The key of using Bayesian network to conduct trust evaluation is to calculate reliability of nodes, its definition and calculation formula will be given as following.

Definition 9: reliability of nodes. Its degree of valuation of corresponding attribute of each node conforming to expectancy. Suppose that Node is one trust node in Bayesian network, and its reliability is expressed as T(Node)=f(Parent1,…, Parents),($1 \le s \le k$), Parents is the attribute corresponding to father node, and k is number of father nodes of the current node.

Suppose the total number of user experience of the current composite service is n. In the meantime, in order to effectively conduct reliability calculation, divide valuation of each trust attribute into several grades, and suppose that Node is divided into L grades. Use $|Node_i|$ to express the frequency of valuation of Node attribute placing in grade i and use the probability of valuation of Node attribute placing in grade i. Use formula 1 to calculate prior probability of reliability of Node.

$$P(Node_i)=\frac{|Node_i|}{n},(1 \le i \le L), \sum_{i=1}^{L} P(Node_i) = 1 \quad (1)$$

Suppose that one father node Parent is divided into Ms grades, use $|Parent_{s-j}|$ to represent frequency of valuation of Parents attribute placing in $grade_j$. Use formula 2 to calculate prior probability of reliability of father node.

$$P(Parent_{s-j})=\frac{|Parent_{s-j}|}{n}, (1 \le s \le k, 1 \le j \le M), \sum_{j=1}^{M} P(Parent_{s-j}) = 1 \quad (2)$$

According to the above definitions and instructions, suppose that there are k father nodes of the current node, respectively use Parents to express them, and each father node is divided into Ms grades, then input attribute of the current node can be expressed as ($Parent_1$, …, $Parent_k$).

We give a conditional probability table (CPT) as shown in Table 2.

Table 2

Conditional Probability Table (CPT)

		($Parent_1$, …, $Parent_k$)				
		(1,…,1)	…	(x_1,…, x_k)	…	(M_1,…,M_k)
$Node_i$	1	P(($Parent_1$, …, $Parent_k$)/$Node_i$)				
	…					
	L					

The left side of the table is valuation of Node with L probabilities, the upper column is valuation of father nodes, (x_1,…, x_k) represent valuation attributes from $Parent_1$ to $Parent_k$ at their own nodes with $\prod_{s=1}^{k} M_s$ valuation probabilities. There are $L \times \prod_{s=1}^{k} M_s$ conditional probabilities in CPT of this node.

Use P(($Parent_1$, …, $Parent_k$)/$Node_i$) to represent conditional probability of father node being located in grades (x_1,…, x_k) when the node is in grade i.Calculation method is as shown in formula 3.

$$P((Parent_1,\dots,Parent_k)/Node_i)=\frac{|Parent_1 = x_1,...,Parent_k = x_k|}{|Node_i|}.(1 \le X_i \le M_i),$$

$$\sum_{i=1}^{L} \sum_{j=1}^{total} P((Parent_1, \dots, Parent_k)_j / Node_i) = 1 \quad (3)$$

By virtue of Bayesian formula, can calculate reliability of current node when valuation of father node is within a scope as shown in formula 4.

$P(Node_i/(Parent_1,\ldots,Parent_k))=$

$$P(\frac{(Parent_1,\ldots,Parent_k)}{Node_i})P(Node_i)/P(Parent_1,\ldots,Parent_k) \quad (4)$$

5.3 Calculate trust probability of Service

In Definition 6, trust decision attribute (TDA) and trust condition attribute (TCA) are defined. TCA affects the value of TDA and most of the TCA conduct trust transitivity through logical relationships. The strength of this trust transitivity can be evaluated by the calculation method given in 4.2. For strong trust condition attribute (TCA') which not only affect the trust attributes of the next logical state, but also affect the values of other subsequent trust attributes, the trust transitivity multiplication formula and trust threshold setting methods can be used to find these strong trust condition attributes.

Use $path_i (1 \le i \le n)$ to represent trust paths from trust condition attributes to trust decision attributes, formula 5 shows the trust calculation of the trust path.

$$T(path_i) = \frac{\omega_1 \times \sum_{i=1}^{N} T(component_i) + \omega_2 \times \sum_{j=1}^{N} T'(component_j)}{\|W\| + \|DD\|} \times (1 - \Delta t) \quad (5)$$

In formula 5, T(componenti) means trust probability of common trust condition attribute(TCA), T'(componenti) means trust probability of common trust condition attribute(TCA'), both of which can be calculated by Formula 4, ω_1 and ω_2 are weight factor, $\| W \|$ means the total number of logical nodes (trust delivery times) on the trust path, $\| DD \|$ means the number of all trust condition attributes that are data dependent on the trust decision attribute. Considering that the longer the trust path, the lower the credibility, use $(1 - \Delta t)$ to reflect this decline, Δt is attenuation factor.

After measuring the trust probability of all trust paths, the last step is to integrate the trust of each path into the overall trust of the service composition, which can be showed in formula 6.

$$T(Composition) = \sum_{i=1}^{N} T(path_i) \times \beta_i \quad (\sum \beta = 1) \quad (6)$$

In formula 6, β_i means weight factor of each trust path.

6. Experiments and Analysis

Trust model establishment has been specified in the above by combining business cases, effectiveness of Artifact-Centric trust evaluation mechanism (ACTEM) will be further verified through a simulation experiment, and experimental procedures are as following:

Firstly, cleanse data in current business system to meet requirements of evaluation mechanism.

Secondly, randomly select training sets constituted by students' course selection records from business data, set three groups of training sets with data scales being 3000, 2000 and 1000, set different trust attributes(the same TDA and different TCA) for each group of training sets. The specific parameter settings are shown in Table 3.

Table 3

Experiment parameter setting

Group	Number of TDA (Teaching assesment)	Number of TCA (procedural nodes)	size of training set
A	3	5	3000
B	3	10	2000
C	3	15	1000

Establish Bayesian network based on the trust model, calculate conditional probability and determine node reliability.

Lastly, randomly select verification sets constituted by students' course selection records from business data with specified data scale. Data in verification sets will respectively traverse Bayesian networks given by three groups of training sets, and use real data to compare prediction accuracy of node reliability. Results are as shown in Fig. 6.

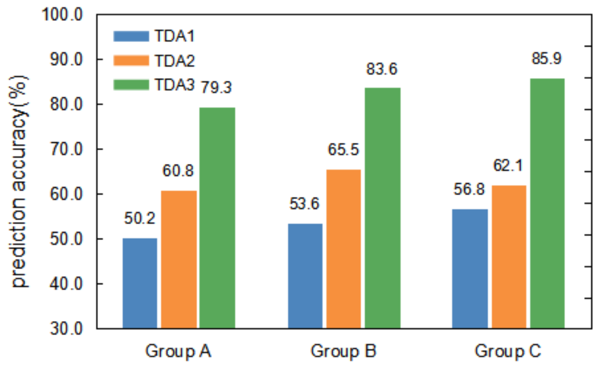

Fig. 6. Comparison of prediction accuracy with different size of trust attributes

It can be seen by comparing prediction accuracy at the same TDA node of three training sets that: training set with more procedural nodes (TCA nodes)have higher accuracy. This tendency is quite obvious when comparing the data of group A and group C. Although the data scale of group A is larger, the number of TCA nodes in Group A is relatively low, the prediction accuracy of group A is lower than that of group C.

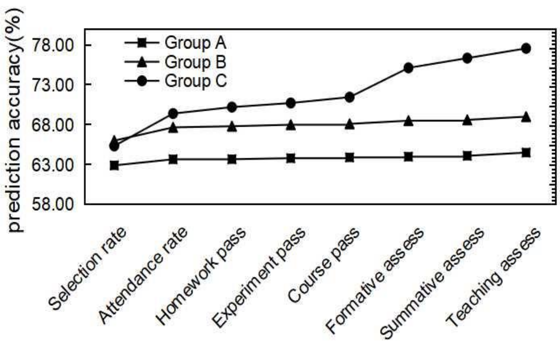

Fig. 7. Comparison of prediction accuracy with different size of training sets

In order to further verify the impact of process data on service trust, change the training sets to further observe prediction accuracy of node reliability. On the basis of Group A, B and C, keep the TDA nodes unchanged, procedural nodes are divided into common condition attributes (TCA nodes) and strong condition attributes (TCA' nodes), reconfigure three training sets by changing the trust weight in Formula 5, and randomly select verification sets again constituted by students' course selection records from business data with data scale from 500 to 10,000. Comparison the prediction accuracy of this three training sets, results are as shown in Fig. 7. It can be seen by comparing the average prediction accuracy of the same TDA node that: with the increase of data scale, the average prediction accuracy has also improved. In group c, with more procedural nodes (TCA nodes), this trend of increasing prediction accuracy is more obvious.

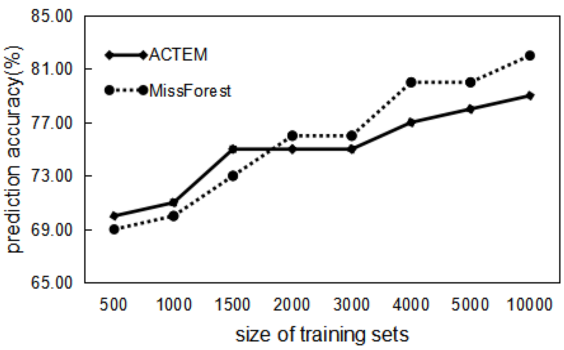

Fig. 8. Comparison of prediction accuracy with ACTEM and MissForest algorithm

To further evaluate the performance of ACTEM, it was compared with the MissForest algorithm proposed in reference 24. The experimental data came from Open University Learning Analytics dataset (a large distance-learning database), the comparison item was the withdrawal prediction. Number of TDA was set to 3, Number of TCA was set from 500 to 10,000. Comparing the prediction accuracy of this three training sets, results are as shown in Fig. 8. The results of the experiment are close to those of the previous experiment, when the data set is larger, the accuracy of ACTEM shows greater accuracy.

7. Conclusion and Future Work

Composite service (Larger-granularity service) containing complicated business logic and data interaction is a tendency of Web service development, and fine trust evaluation should be given by facing specific user objects and business data. This paper introduces a new solution based on business process modeling idea which focuses on data in the field of trust evaluation of Composite services, establish business model and trust model for Composite services based on Artifact, put forward a trust evaluation mechanism based on business process by relying on Bayesian network, and certify effectiveness of the model and evaluation mechanism through a simulation experiment. Existing research studies are conducted mainly on the basis of prior data, so the next step is: based on perfecting Artifact procedural data capturing mechanism, establish a dynamic trust evaluation mechanism in order to improve accuracy of trust prediction.

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