Applying Rely/Guarantee in Compositional Ontology Alignment

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Abstract—There exist different traditional methods which can help in aligning the entire ontology. The ontology can be aligned either with the comparison of matching two similar ontologies, or by comparing classes with the globally published class or the class which has been reused within the same ontology. However, traditional methods are ineffective as being dependent on either the attributes defined within the class or by checking their semantics and therefore providing attribute to segregate classes of same nature. We adopted the idea of Rely/Guarantee from distributed systems area, while proposed the same to align Ontology, which can actually align the class more efficiently, making the Ontology the effective one.

Keywords: Assumption/Commitment, Assumption/Guarantee, Ontology Alignment, Extensional Technique, Parallel Method, Rely/Guarantee, Rule of Consequence, Semantic Technique, Structural Technique, Terminological Technique.

1 INTRODUCTION

Ontology is the way to provide interoperability of different classes over semantic web. The better the ontology is constructed, the more are the chances for tight integration between different processes, no matter they are within the organization or are indirectly connected to organization, including external stakeholders i.e. Customers, Suppliers and Outsource services. For a properly design Ontology, it is always a mandatory step to apply different methods for Ontology Alignment. This propagates the reusability approach of a single object, thus at different instances, same property or attribute can be declared, rather going for heterogeneous environment. We have different traditional methods to align the ontology, however we are going to propose new method, adopted from the other domain, to better align the ontology. We will keep our focus to Organization Ontology, so a better understanding can be developed.

2 PREVIOUS WORK

Rely/Guarantee was utilized in distributive computing area, where shared variable is utilizing in concurrent programs [1]. The proposed logic can be automated easily [2]. In it, a process is divided into sub-systems [3] so as to classify outcome of each process. Shared variable in parallel processing is the most common method for composed systems to work efficiently [4] [5].

With Rely/Guarantee, assumptions and contrains can have constraints on single step that includes if which one of the two parallel processes would be executed. However, with the advent of assumption/commitment [6], and its refined version later [7]. This says that the outcome of one of the process is actually the input of the other process, provided that both the processes should satisfy the environmental factor.

Hierarchical system modeling and verification [8] is the top most method to introduce the structure of e.g. organization. There exists the verification method, however there is not such direct method to actually verify the entire hierarchy at once. Model checking [9] is the traditional method to verify the hierarchy. Further, there exist verification tools for heterogenous system as well which is automatic [10]. In state space explosion, models become so large that the aforementioned algorithm fails, so the alternative is to decompose the entire hierarchy [11] and apply the methods.

There are some verification tools which have implemented model checking in different domains. For heterogeneous systems, there is an interactive verification environment called, MOCHA [16],[17]. UPPAAL [19] is an automatic verification tool suite which targets on safety and bounded liveness properties of real-time systems. SMV [18] and its related tools can be used to verify RTL level designs easily. To verify distributed software systems, Spin [19] is an another popular software model checking tool. The newest manipulation/verification tool, SGM (State-Graph Manipulator) [21], can be used to manipulate state graphs and verify real-time systems. Even though we have so many useful model checking tools, model checking still has some problem in general use.

The main idea is therefore to split the entire process into different parts, verify them individually [12] [13], and if all are verified, that means the system is verified [14]. With the idea, to align the ontology, we can decompose the hierarchy, verifies if each class satisfies the environment, and if the preceding class does also satisfy, it means the classes are well aligned, therefore guaranteed. Rules of Rely/Guarantee is provided and proved in the paper [15].

3 USE CASE—ORGANIZATION ONTOLOGY

3.1 Background

Product/service innovators gain much more capital by
operating their organizations through web-services or by utilizing new or improved technologies to up-lift the market for better living and luxurious life. Today, it is though easy to get into the market; however problems lie within their sustainability. We proposed Ontologies of Organization structure and engineering its information management in semantic world.

However, to have interoperability between the defined objects / instances, attributes or properties in OWL ontologies, we have to have ontologies that we can reutilize, either for exchange of messages between two different ontologies, or making unique dictionary to reutilize attributes and properties of same object, thus garbage classes can be declared obsolete.

3.2 Introduction

We all know, to start up the business, we first need to have a target for which industry we are focusing to. Then we move to two main parts i.e. what would be the internal and external factors or forces that may influence on the business. Most importantly, internal factors can be managed easily in comparison to external factors however external factors are a bit difficult to manage, being involvement of out-of-control stakeholders. We will describe it in detail of what these actually mean.

3.3 Industry Knowledge

Industry-Knowledge is prerequisite to design any structure of an organization. For business needs, we have to cover different aspects. We have different functions which include Financials, Legal, Resources, Maintenance, and Production etc. However, it is not a good idea to have a flat hierarchy which is difficult to manage for any business. It should be well structured. Though the communication will get slow, but due to utilization of recent technologies, this is not an issue. The other drawback is there are a high-dependency on Jack-of-All people, being flat hierarchy, while in structural; there are specialized people for each function.

With the aforementioned idea of having a structural organization, we can group the similar functions having same attributes. We segregate them as Internal and External, being top level node. We will then further divide the concept to main category, include Financial, Ethics, Legal and Infrastructure.

Broadly, we can define organizations as follows:

4.1 Productivity

This class emphasizes on monitoring the overall performance through the utilization of different analytical tools for effective decision making.

4.2 Human Resource

This class refers to the Human Resources within the organization. This includes recruitment of talent, their compensation, training and effective communication to move into desired direction.
This area deals in distributing the product or service in effective manner by calculating cost-benefit analysis for utilization of distances/resources, so organization should not expense out in vain. This eventually leads to more profit.

**4.4 Process Integration**

This actually identifies gaps within internal and external processes of an organization. It focuses on keep optimizing the processes and fill the gaps with the well-define process to capture all event within organization with audit trail while provide quick communication channel.

**4.5 Information Management**

This manages the information being maintained within the organization within the integrated or non-integrated process to enable referral of information in future, while feeding information for trend analysis, defined in productivity class.

**5 Ontology Alignment - Traditional Methods**

**5.1 Terminology Technique**

This technique caters the alignment through the terminology or syntax of the class. The entire ontology is traversed, and each class is checked for its recurrence. The runtime is therefore O (n2). It’s a time consuming and might not align the ontology, as not all syntax can simply be mapped.

**5.2 Structural Technique**

This technique deals in matching structure of each class in Ontology. This means that attributes of each class are matched, that may result in the similarity of one or more than one attributes to be matched. Thus finding similarities and coming up with the ideal similar class generalizes the class. At the end, it results in aligned ontology.

**5.3 Extensional Technique**

This technique deals in aligning the classes in ontologies, depending on their instances. So, the similar instances can be compared and if found with the same value, their classes are made similar. This results in aligned ontology, which is better than the structural technique.

**5.4 Semantic Technique**

It can further be elaborated in a way that the first stage should be testing the class on syntax basis and then comes to the local semantics of particular class. If it doesn’t match, try to find the class in global semantics. This will apply interoperability on the defined classes. For being effective, reference of syntax and its semantics should be followed by same repository. Thus, proper Descriptive Language is mandatory for such technique.

**6 Application of Traditional Methods**

**6.1 Introduction**

We can see from the classes that if we take Reports class, terminologically, they are same in Human Resource and Productivity. While within Productivity, Reports, Dashboards, Charts, Bar Charts and Line Charts have same attributes. Therefore, by structure method, they all are same. In combination of these two methods, we can conclude that all of the aforementioned classes are instances of single class. Therefore, through the application of two traditional methods, we actually made them aligned.
However, if we further extend in traditional methods for alignment, we can see that there are very few classes which are similar as per extensional technique, i.e. Sharing and Distribution in Information Management, while numerous classes are semantically similar and therefore can be applied to align the remaining ontology. This includes Package, Cost Benefit, Compensation, Budget and Allowance as instances of single class with identifier as its attribute. The other one is Position, Router, Interviewer, Domain Expert and Recruiter, which are instances of class People.

In summary, we can conclude that only few classes are aligned within the entire Organization Ontology by applying traditional methods of alignment. In following section, we will introduce new method to actually align entire class in a better way.

6.2 Detailed Analysis

From above, we can clearly see that except sub-classes of Processing, none can be directly aligned with each other. However, instances of many classes can have additional attribute of “Type” to make a same data-model for interoperability. However, following main classes are not even partially be aligned or aforementioned method cannot directly be applied

6.2.1 Operations

Productivity operations are referred to as monitoring the performance of the organization by keeping an eye of the operations. This process include not only monitoring the processes but also taking prompt decisions as to gain more and more capital. For operations, we have defined links to external bodies, acquisition of lands and financial assets etc. This, therefore include Business Development as well as Process Engineering as an attribute.

6.2.2 Mining

Mining is to actually apply statistical algorithm on the past data, resided in data warehouse to extract meaningful pattern of information to take decisions of where to invest further according to the predicted revenue or net income. This includes the attributes of characteristic, key-figures and dimension, while it requires data-warehouse as a database repository as well:

6.2.3 Applications

Terminologically, Process Engineering, Business Development Techniques, Data Warehouse, Data Characteristics, Data Attributes, Statistical Algorithms and Data Dimensions are not similar or same to any attribute of any of the other class. Therefore we can say that they are not terminologically able to align.

Structurally, as Process Engineering includes development of the process, Business Development Techniques include techniques to expand organization horizontally, Data Warehouse which is the archive data of many years, Data Characteristics, Data Attributes, Statistical Algorithms and Data Dimensions are characteristics of data analysis but are not similar or same to any attribute of any of the other class. Therefore we can say that they are not structurally able to align.

Extensionally, Process Engineering, Business Development Techniques, Data Warehouse, Data Characteristics, Data Attributes, Statistical Algorithms and Data Dimensions have not instances of which upper and lower nodes are same to any attribute of any of the other class. Therefore we can say that they are not extensionally able to align.

Semantically, Process Engineering, Business Development Techniques, Data Warehouse, Data Characteristics, Data Attributes, Statistical Algorithms and Data Dimensions are not in any way having same meaning with that of any other attributes of class. Therefore we can say that they are not semantically able to align.

6.2.4 Advertising

Advertising is actually to make the customer aware of the product or service and let it be marketed in the specific area, by targeting specific category of groups. Therefore, it has the attributes of Clients, Method of Advertising (i.e. Printed, Online, TV, Radio, Banners etc.).

6.2.5 Market Response

Market Response is actually to check how the market responded after the roll-out of service/product in particular area. This means to check the customers intention to buy next time. This helps in identifying the pattern of why the people have bought, what is the demand rate and how much should the production be for next time, while if any value-addition is required for the next release. Therefore, it has the attributes of Area, Value of Product/Service, Response and Demand

6.2.6 Applications

Terminologically, we can see that there isn’t any attribute that are similar or close to similar. Area, Value of Product, Response and Demand, none is equivalent to any attribute in Ontology. Similarly, Clients and Method of Advertising are also not available in entire Ontology. Therefore, they are terminologically exclusive attributes.

In terms of structural comparison, we have different structure of Area, Value of Product/Service, Response and Demand, while we have different structures of Clients and Method of Advertising. Therefore, structurally, they are different with each other and therefore the method cannot be applied to align the ontology.
Extensionally, as none of the class has instances, that is no parent and child nodes exists of particular nodes of Area, Value of Product/Service, Response and Demand, Clients and Method of Advertising. We can conclude that this method to align the classes in ontology is inapplicable.

Semantically, as Area, Value of Product/Service, Response and Demand, Clients and Method of Advertising which are attributes of two classes, are all different in their meanings, and have different purpose for different objects, we can state that the method is inappropriate to align the classes in ontology.

6.2.7 System

By System, we mean to have instances of different applications, software and hardware in place, so as to integrate them and make the data interoperable. The attributes include Application, Software, Hardware and Databases,

6.2.8 Network

It’s the class to represent connectivity in between systems. This enables developing communication channel in between different systems so as to create smooth transition of the messages, that can be signals from the interconnected systems or messages sent through systems by means of application. The attribute thus include Wires, Protocol, Servers and Infrastructure.

6.2.9 Traditional Methods

As terminologically, we don’t have any term within attributes in Application, Software, Hardware and Databases from System and Wires, Protocol, Servers and Infrastructure attributes from Network that are similar or same, the method is inappropriate for aligning the ontology

Structurally, we have different architecture of Application, Software, Hardware and Databases from System and Wires, Protocol, Servers and Infrastructure attributes from Network. Therefore we cannot relate the classes and make them unique. The method is therefore not applicable for aligning the ontology.

Extensionally, as there aren’t any instances in parent and child node exists of any of the attribute in Application, Software, Hardware and Databases from System and Wires, Protocol, Servers and Infrastructure attributes from Network, the method is inapplicable.

Also, as semantics of the attributes Application, Software, Hardware and Databases from System and Wires, Protocol, Servers and Infrastructure attributes from Network are all different, as each is representing different meaning, the method is therefore not applicable in this case to align the ontology.

Storage

To save data in a persistent area, while retrieving it for future utilization, we have the class of storage, that have different attributes of where to store the data, in which format the data should be stored, what encryption method is to be used and in which type it should be saved. Therefore, having the attributes of Location, Format, Encryption, Data Type.

6.2.10 Sharing

By sharing we mean to retrieve data and send or provide access to currently unassigned stakeholder that can either be any user, application or system. The attributes of which are Source, Destination, Access Rights, and Ability to Re-share.

6.2.11 Applications

Terminologically, the attributes of unaligned classes in our ontology have different attributes including Location, Format, Encryption, Data Type from Storage and Source, Destination, Access Rights, and Ability to Re-share from Sharing. As it can be seen that no one attribute is similar to any other attribute in entire ontology, therefore we can say that traditional methods are inapplicable.

Also, as attributes including Location, Format, Encryption, Data Type from Storage and Source, Destination, Access Rights, and Ability to Re-share from Sharing are different in structure, and that not a single is equivalent or similar to other attribute, we can conclude that structurally, they are different

Extensionally, as none of the class has instance of parent and child node, we cannot have any class exist to compare the instances. We can therefore conclude that extensional method is inapplicable.

Semantically, as attributes including Location, Format, Encryption, Data Type from Storage and Source, Destination, Access Rights, and Ability to Re-share from Sharing are having different meaning in the same context, while they are used for different purposes, we can say that the class remains unaligned through semantic method.

7 PROPOSED WAY FOR ONTOLOGY ALIGNMENT - RELY/GUARANTEE

7.1 Introduction

In the past, it was easy to make an output of a system as an input of another system. This is because all the programs being generated were actually based on sequential methods. That is, the systems always rely on the output of its dependent system. However, when it comes to parallel processing, more research was performed which results in providing solution as an integral way, which was previously being done independently.
Rely-Guarantee, or in other words Assumption/Commitment is a method which assumes that not only a component is verified by just satisfying all of its commitments, but also verifies all the assumptions, being exposed from the internal or external environment.

This can better be explained with the real-life example that if we want to have dinner, we can either go out to some restaurant, can cook at home, or can place order to get it delivered at the doorstep. Now, the process of having dinner is dependent on either or the commitments from the mentioned processes. For first option, we need to drive way to the restaurant to reach the destination, so “Traveling” is the process which needs to be committed. Similarly, if we want to cook at home, we first need to go for “Shopping” to buy ingredients. The process commitment will enable us to cook or Initiate cooking process, so that dinner system can be practiced. The last option is to let the dish be delivered at home. For that, two commitments, a phone call and book and order while another process by the delivery-boy to bring it to your doorstep, should be committed so have dinner.

So, if all the assumptions from the environment are verified, while the commitments are fulfilled, the system can have its input to ignite the system. In other words, all pre-requisite systems should have commitments in order to provide feed to dependent system to let the process flow

7.2 Rule of Thumb

So, rely guarantee works on the rules that if the first state satisfies the initiating process and all the state being changed are relying (R), then every final state will satisfy the final process and every next state within the processing is guaranteed (G)

\[ R, G \vdash \{ P \} \subseteq \{ Q \} \ldots (1) \]

7.3 Structure

Any analyst can better come up with the systems and apply the assumption/guarantee method to align the ontology of that particular system. For that, the analyst first have to come up with the no. of systems exists within entire system. This means to, bifurcate the entire process into small systems which are dependent on each other, if related. The focus while deriving the sub-systems should be on how the system verifies the initial process, and all sub-systems do rely on prior system to come-up with the consequence.

The technique can be adopted to align the ontologies. That creates the possibility of aligning such ontologies that cannot be aligned with the traditional methods. We will further discuss different methods to align the ontologies in different ways. Further, with the methods, we can also automate the alignment process by developing a program that can align ontology accordingly

7.4 Methods

7.4.1 Parallel Rule

With parallel rule method, we mean to have different processes being run at the same time, i.e. simultaneously. We can better explain it with the following example.

Suppose we have to come up with the minimum no. within a provided list of nos., say 100. If we go with the sequential processing to identify minimum no. though an environment for parallel execution is available. We need to traverse entire hierarchy, the complexity of which will become \( O(n) \). However, with parallel rule, we can execute matching algorithm by splitting the number range in even and odd values. Each list will have 50 nos. Then we can execute our matching algorithm on both the list in parallel which results in half of the time as was done earlier. At final, we have two values of the two lists. We can therefore conclude that the smallest no. among two identified nos. is the lowest in the range.

So, IF

\[ R \cup G_2, G_1 \vdash \{ P_1 \} \subseteq \{ Q_1 \} \ldots (2) \]

\[ R \cup G_1, G_2 \vdash \{ P_2 \} \subseteq \{ Q_2 \} \ldots (3) \]

THEN

\[ R, G_1 \cup G_2 \vdash \{ P_1 \land P_2 \} \subseteq \{ Q_1 \land Q_2 \} \ldots (4) \]

Later, we will apply the Parallel Method on one of our modeled class to get its outcome and compare it with the other proposed method for Rely/Guarantee.

7.4.2 Rule of Consequences

In rule of consequences, we assume that if the dependent state satisfies with all the environment assumptions and the next state satisfies the same assumptions, the outcome will also guarantees to satisfy the all the assumptions.

Therefore, if Initial Process (P) satisfies all the assumptions (R), while the final process (Q) satisfies all the assumptions (R), which was earlier satisfied by P as well, and if the effect is guaranteed and is contained in (G), then

\[ R, G \vdash \{ P \} \subseteq \{ Q \} \ldots (5) \]

In other words, if all the processes are relying, and feeding input to other process which also satisfies the assumptions, than within the two processes, guarantee exists. The change states will be maintained in Guaranteed state (G)

With a real-life example, we can better explain the method. For instance, if we have a process to spend holidays (Process 0), we need to book the tickets (Process 1), need to purchase clothes (Process 2), and need to purchase fresh-food (Process 3). For Process 0, we first need to proceed for Process 1 as its outcome will inform either to trigger Process 2 and Process 3. This is the consequence-rule way of assignment/commitment.
However, Process 3 and Process 2 can be run in parallel as Process 3 can be triggered by ordering, while Process 2 is what we our-self have to do. So, in a same time, both the processes will be executed, thus being followed in parallel. However, this parallel execution is a consequence of Process 1. This means that Process 1 satisfies the assumptions, while Process 2 and 3 satisfies assumptions only if Process 1 satisfies, i.e. If tickets are booked, than the shopping and food purchase is executed, while if tickets are not booked, both the dependent processes will not be executed. This endorses applicability of Rely-Guarantee.

In other words, IF

\[ R \subseteq R', G' \vdash \{P\} \subseteq \{Q\} \subseteq G \quad \text{(6)} \]

THEN

\[ R, G \vdash \{P\} \subseteq \{Q\} \quad \text{(7)} \]

8 Rely/Guarantee Approach to Alignment

8.1 Background

We aligned ontology through traditional methods and able to streamline few of the classes. However there were numerous classes that we didn’t able to align. Among them we will discuss the high level alignment at class-level while we will discuss attribute level alignment of classes at second level. For that, we first need to identify the business processes within an organization to capture the data flow between different processes, sections and departments, as well as function.

Let’s focus on the Productivity class, while restricting its access to other dependent classes, Marketing, Human Resource and Sales. Following are the hierarchies of our ontology

Thus, applying Rely/Guarantee, we get that the Business Goals should be the main class, while Sales has to focus on Business Goals, e.g. Increase Sales by 20%. For that, they need to market that product and there is where Market class becomes functional. After getting functional, Human Resource would be either required to hire, or mobile them to achieve particular goal. The entire system feed data to Productivity class, where management can monitor their goals if at any instance, its achievable or not and can take prompt decisions/actions for effective functioning of the organization.

Communication class under Human Resource can be aligned by relying on its prior class, job specification of human resources. As we can see that if the external environment which in our case is goal of the management satisfies assumption that each position is classified as per their specification, then next class will surely be assuming the same properties. Thus, any communication be transmitted through technical channel will be understood as per their background knowledge. Therefore, the satisfaction of specification based communication will be same as being in the relevant context. Therefore we can assume of the guarantee that correct message will be conveyed to stakeholder

Trend Analysis and Mining under production also can be aligned in a way that if all the sales information is correctly maintained within the data warehouse, i.e. satisfying the environmental factors, then mining through different statistical algorithm can be performed, maintaining the same environmental factors. This is through the consequence rule. However, internally, the mining can be done in parallel, in the way to apply algorithm on different regions simultaneously. So, if we want to find maximum sales as per region, we can perform max function on information, executed in parallel to display the required output.

Similarly, advertising is initiated when an outcome from market research department is provided. This contains information of where and of what category of people the target should be, on the basis of which the Advertising department works out on different medium and comes up with the effective one, to propagate the message to masses.

Market response is therefore analyzed, which is the outcome
of the advertising to feed information to sales department to start their function.

Thus, at every stage, it all depends if each process is being satisfied with the external environment and other variables. If so, the other stage is then evaluated on the same factors and if it satisfies as well, this means they have rely.

The above can better be executed in the following way:

1) Run in Parallel
   a) Input Parameters of Productivity class is the data resides in data warehouse. Therefore existence of data warehouse should exists
   b) Output Parameters, which includes graph, trends and predicted values/patterns after processing will results in Mining.
2) Check (1a) and (1b) in the entire Ontology. We can see that Analytics, Dashboards and Reporting, all have these parameters.
   a) Replace class Analytics to Dashboards, Reporting as well as our Input Class Productivity.
   b) Goto (1) and check Input Class Servicing Customer
1) Run in Parallel
   a) Input Parameters is the Sales Data, which helps us analyzing the market
   b) Output Parameter would be the analysis, which is Analytics class, which we already aligned above.
2) Check entire Ontology;
   Market Response is actually the output of Sales, which in turns is the output of Advertising. Therefore, we can see that Output Parameter of prior class is actually the Input Parameter of Market Response
3) As (2) finds Market Response similar to Customer Feedback class, as having same Input and Output of the class, therefore replace all found classes to Market Response.
Thus aligning the Ontology.

For the other ontology, e start with explaining process integration. All business processes should be well-defined to capture each and every event within the process. This is only possible with the tight integration with the processes. Thus, within the sub-processes, we have Rely/Guarantee approach that one of the process transfers data to other sub-process, thus completing the entire process cycle. Every sub-process satisfies the same environment factors, for the reason their results contain in a guarantee (G). For example, obeying company, corporate and legal law the purchase department procures by going through the procurement process, which gives outcome to finance department to pay for the procurement. Thus, two different departments rely to finally get guarantee.

As each department satisfies common environment, they can be made as a single class, the attributes would be same, though they cannot be aligned through traditional method as none of their attributes matches with each other.

Thus, the process integration with Rely/Guarantee can be achieved. However, for that, system integration also comes into play. Without integration of systems, process integration is not possible, as data can get corrupted or incorrect data can flow in the process. For that, Process Integration, having same environmental factors, guarantees the flow of information, and as an outcome, system integration takes inducts it into their channel to let it flow to other process. Thus, it follows Rely/Guarantee method. This can become sub-class of the Process Integration class, as an instance can be created within it.

Managing Information is another class which seems independent of system and process integration. However, if we apply Rely/Guarantee, we can find that through this class, the processes are being relied, while systems are just the hardware part of it. Thus, with different sub-classes, the process integration can be achieved. For example, Sharing class of Information management actually lets outcome of the process A to feed to Input of process B.

8.3 Aligning two Ontologies through Rely/Guarantee way
As Information Management is an integral part of any Organization. We can apply alignment method to make it interoperable so that the ontologies can tightly be integrated. We earlier saw that through traditional method, we are unable to integrate Information Management Ontology with Organization Structure Ontology. Although it should be tightly integrated as all the data flow through the channel. System Integration and Information Management are the core classes that can actually integrate two of the Ontologies. We earlier proved that no traditional method is applicable to make the two mentioned classes aligned so as to make them interoperable.

With our proposed method, in above section, we were able to align the Ontology, thus making them integrated with Organization.

Through Rely/Guarantee, we can integrate the Ontologies as follows, (applying parallel rule)
8.3.1 Customer Analysis

1) Run in Parallel
   a) Input Parameters is the Sales Data, which helps us analyzing the market
   b) Output Parameter would be the analysis, which is Analytics class, which we already aligned above.

2) Check entire Ontology;
   Market Response is actually the output of Sales, which in turns is the output of Advertising. Therefore, we can see that Output Parameter of prior class is actually the Input Parameter of Market Response.

3) As (2) finds Market Response similar to Customer Feedback class, as having same Input and Output of the class, therefore replace all found classes to Market Response. Thus aligning the Ontology.

8.3.2 System Integration

1) Run in Parallel
   a) Input Parameters of System Integration class is the data resides in application, software which itself in some hardware. Therefore existence of application persist
   b) Output Parameters, which includes providing functionality to run data, while with proper authentication and network channel

2) Check (1a) and (1b) exist in the Ontology by traversing each node and testing its input and output parameters
   a) Input of Database Application is same as of System Integration
   b) Output of Database Application is same as of System Integration

3) IF found similar, DO
   a) Replace the class with name of later identified class
   b) IF Input Parameter was of last node, STOP loop ELSE
   c) Goto (1) to fetch new Input Parameter

8.3.3 Information Management

1) Run in Parallel
   a) Input Parameters of Information Management class is the data resides in application as Storage attribute
   b) Output Parameters, which includes providing functionality to share data on common channel with proper authentication

2) Check (1a) and (1b) exist in the Ontology by traversing each node and testing its input and output parameters
   a) Input of Database Application is same as of System Integration
   b) Output of Database Application is same as of System Integration

3) IF found similar, DO
   a) Replace the class with name of later identified class
   b) IF Input Parameter was of last node, STOP loop ELSE
   c) Goto (1) to fetch new Input Parameter

8.3.4 Productivity

1) Run in Parallel
   a) Input Parameters of Productivity class is the data resides in data warehouse. Therefore existence of data warehouse should exists
   b) Output Parameters, which includes graph, trends and predicted values/patterns after processing will results in Mining.

2) Check (1a) and (1b) in the entire Ontology. We can see that Analytics, Dashboards and Reporting, all have these parameters.
   a) Replace class Analytics to Dashboards, Reporting as well as our Input Class Productivity.
   b) GOTO (1) and check Input Class Servicing Customer

In summary, the output of the one sub-system is being provided as information being input in later system so as to make the ontology aligned and integrated to make it interoperable in semantic world.

9 RESULTS

Through traditional methods, we were able to align Productivity and Information Management classes only, while through the collaborative method of Rule of Consequences and In-Parallel of Rely/Guarantee method, we were able to develop the flow of entire processes, how the outcome be feed to next class as income, and if earlier class satisfies the environment, the consequent class also satisfies, which helped us making the entire Ontology, aligned. This includes, goal of the organization being communicated to Marketing, while their
relevant staff started working on the market research. As research is dependent on goal, environment is therefore satisfies. This follows till the productivity, where everything is monitored. We found that single Productivity class can be created and in-parallel, multiple instances i.e. Dashboards, Reports, etc. can be executed. Though, they initiated through rule of consequence as satisfying the environment, however executed in parallel. Thus Rely/Guarantee is much more effective than the traditional techniques of Ontology alignment.

10 CONCLUSION

Extensive research was done on traditional method earlier, while it is difficult to apply on entire Ontology, which usually is complex. With the new proposed method of Rely/Guarantee, it is expected to develop grounds for further research in this area for effective alignment of the ontology.

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