ARTIFICIAL INTELLIGENCE FOR QUERY INFERENCE IN MANUFACTURING MANAGEMENT DATABASE

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Summary

Our recent studies for Framed Knowledge Base convinced us of an application for machinery assembly database and as seemingly, the function of 'Association implemented in Framed Knowledge Base is extraordinary among Artificial Intelligence abilities. Physical meaning prevailing between two members at an assembly interface could be identifiable by the 'Association. Therefore, once a certain type of assembly is specified for query, every component attached or connected are retrievable instantly upon request as well as their physical conditions at the interface. Other form of fabrication process, is also conceivable by means of this 'Association. Building scripts for the semantic knowledge is pretty straightforward relying on the actual arrangement of parts and elements, which is approximately proportional to that of physical dimensions. Contrasted with scripts for an accustomed relational database, our scripts for the Framed Knowledge Base is outstanding in intricacy and susceptibility for building query system for a machinery problem interrogation. Keywords: Knowledge Base, Artificial Intelligence, Expert System, Thesaurus, Semantic Knowledge

1. Introduction

The system consists of an artificial intelligence for search engine and of its knowledge-base for database, which works in conjunction with rule objects and framed knowledge ⁽¹⁾. In the keyword thesaurus of a conventional database system, its structure resembles a root of a tree, so that a typical path of the query process is taking place along nodes and branches stemming from each node ⁽²⁾. In this sense, location and distance between keywords are of the most important attribute to be reckoned with when the set is to be compatible and conformable in the thesaurus tree.

In our study to develop AI thesaurus for two-dimensional objects such as two dimensional Finite Element model in a database, we have already reported that the knowledge-base ⁽³⁾ is of the most promising and compatible tool dealing with the structure of meshed objects in two-dimensions ⁽⁴⁾. As of the search engine ⁽⁵⁾ to operate in conjunction with the knowledge-base thesaurus for Finite Element Method mesh, repetitious nature of the AI engine in a series of queries for node and elements kept in knowledge-base is essential in its algorithm, which in other word, must comply with the iso-parametric operations. This self-propelling algorithm with iso-parametric processing in successive meshes has been examined for a set of nodes and elements in fundamental arrangement. The evaluations for this repetitious nature in a series of query operations looking for outer edge at periphery are made in this report.

2. Artificial Intelligence engine for mesh objects in database

Particularly at an early stage of FEM development for unknown analysis, it is highly beneficial to browse published results, which have similar physical dimensions or boundary conditions with the one of proposed. In this sense, the ability to retrieve figures of mesh as well as literature information associated with the mesh objects in database is indispensable.

Figure 1. General purpose database for composite contents

this case, comprises #node itself, an upper class of #element and own associates of #node_2 #node_1.

Figure 3. Inference through system of frames

5. Conveying records from database to knowledge base

The primary records of finite-element meshes are the node-to-element relationship and geometrical data of each node. These data are kept within a mainframe relational database where the data are packed strategically in the disk device.

The relationships between nodes and elements are set in a RIQS ⁽⁷⁾ database, as shown in figure 4. At the commencement of inferring for the mesh thesaurus, records of the mesh are retrieved from the mainframe computer database {RIQS} (*1 in Fig. 4). Then the values are accumulated once into a set of Instances in {EXCORE} ⁽⁸⁾ (*2 in Fig. 4). At this time, an element and coupled nodes are kept as a series of numbers within a record of 'Instances' (*2 in Fig. 4). These sets of nodes are transformed into a statement of Association (*3 in Fig. 4) where the relationship between an element and a node within a specific mesh is eventually verified.

Figure 4. Records set into knowledge base of EXCORE

6. Frame recognition in knowledge base query

As a result of the query transactions for a database, data that define the relationships of nodes and elements are retrieved and transferred from a database into knowledge base in AI system. There are two types of data sets that have been acquired from the database. The first set is a series of numbers assigned to node, which constitutes a single element. The second is a node number and two coordinates measured along specified coordinate axes.

Two types of FEM meshes are opted to be retrieved from the database. One is a model for plane stress concentration with 92 nodes and the other is that for a thick cylinder composed of nine elements with internal pressure.

Assuming that the first node number is to reside on one of the peripheral edges, the inference takes place

along the circumference border and then continues to cover the entire outer rim of the mesh.

```

RULEBLOCK = Data_Retrieval    RULELABEL = Database_Access
                                TIMING = AFTER
* UPDATE INFORMATION *
VARIABLE = RECORD VALUE = (TRIANG-1 TRIANG-2 TRIANG-3 *1
*** RULE-TRACE 1
    RULEBLOCK = Data_Retrieval    RULELABEL = Record_Display_1
                                TIMING = BEFORE
*** RULE-TRACE 1
    RULEBLOCK = Data_Retrieval    RULELABEL = Record_Display_1
                                TIMING = AFTER
* CREATE INFORMATION *
PREDICATE = (Display 2 8 1) *2
* UPDATE INFORMATION *
VARIABLE = File_ID              VALUE = TRIANG-1 *3
VARIABLE = node1                VALUE = 2 *4
VARIABLE = node2                VALUE = 8 *5
VARIABLE = node3                VALUE = 1 *6
CF VALUE OF (Display 2 8 1)

```

Figure 5. Trace of rule inference at database access

The method of finding the appropriate edge depends on the two nodes at the two sides of the edge, which should not have more than three connections to the adjacent elements. The next edge is decided by the counterclockwise node-to-element relationships (*1,*2 in Fig. 5). The edges found by this method are chronologically tabulated (*3 in Fig. 5) in the form of an instance, as shown in Fig. 5.

Then the lengths of the edges are summarized to obtain the total length of the periphery, which is one of the two dominant properties that describe a figure. The second characteristic of a figure is the area, which the object displaces. That value is obtainable by considering the line of edges as a vector, the algebra of which provides the value for the area within the confines of the circumference.

The first comparison of the figures takes place by referring to these two characteristic values, i.e., the total length of the circumference and the area of the object. The inference engine accepts either of the figures retrieved from the database as a reference for this comparison.

7. Framed knowledge base in joining assembly thesaurus

One of the semantic knowledge application, could be in a query for joining and assembly of a machinery. In this case, machinery components are designated as 'Class (*1 in Fig. 6) and if this component has any auxiliary parts like screw or pin attached upon, a number of 'Instance variables (*2 in Fig. 6) are assigned. In this system of network for inference, one call of query for any 'Class variables such as 'shaft_1 (*3 in Fig. 6), it automatically surrenders entire names of 'Class and 'Instance variables defined within the entire network.

Physical relationship at interface of two component is described by a name of 'Association, such as sliding contact between ball bearing and main shaft (*3 in Fig. 7). There are other names of 'Association, like mounting by 'set_bolt (*1 in Fig. 7) and fastening by a set-screw (*4 in Fig. 7).

Figure 6. Semantic network for pushrod assembly

Figure 7. System of thesaurus for ball bearing and shaft assembly

The Fig. 8 below is of the 'Class description of thesaurus for a machinery assembly system. The top 'Class of 'ball_shaft' (*1 in Fig. 8) represents the name for this whole assembly and secondary sub-assemblies like 'block_1' (*2 in Fig. 8) are also named as a 'Class. One of the sub-assemblies 'push_head' (*3 in Fig. 8) has two parts, which are defined as two 'Instance variables 'set_screw' (*4 in Fig. 8) and 'front_head' (*5 in Fig. 8). Physical contact of two mechanical components at their interface is related by a statement of 'Association' (*6 in Fig. 8). Attaching by 'set_bolts' is named as 'bolt' (*7 in Fig. 8), of which joining status is permanent locking but detachable.

```
( CLASS ( NAME ball_shaft ) *1
  ( INSTANCE-VARIABLE ( stroke NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( CLASS ( NAME block_1 ) *2
  ( SUPERCLASS ball_shaft )
  ( INSTANCE-VARIABLE ( material NIL ) ) )
( CLASS ( NAME shaft_1 )
  ( SUPERCLASS ball_shaft )
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( CLASS ( NAME set_bolt )
  ( SUPERCLASS block_1 )
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( INSTANCE ( NAME bolt_1 ) ( CLASS set_bolt )
  ( INSTANCE-VARIABLE ( diameter (8) ) ) )
( INSTANCE ( NAME ball_bolt_2 ) ( CLASS set_bolt )
  ( INSTANCE-VARIABLE ( diameter (8) ) ) )
( CLASS ( NAME bearing )
  ( SUPERCLASS block_1 )
  ( SUPERCLASS shaft_1 )
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( INSTANCE ( NAME ball_bearing1 ) ( CLASS bearing )
  ( INSTANCE-VARIABLE ( diameter (5) ) ) )
( CLASS ( NAME push_head ) *3
  ( SUPERCLASS ball_shaft )
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( length NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( CLASS ( NAME set_screw ) *4
  ( SUPERCLASS push_head )
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( length NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( CLASS ( NAME front_head )
  ( SUPERCLASS push_head ) *5
  ( INSTANCE-VARIABLE ( material NIL ) )
  ( INSTANCE-VARIABLE ( length NIL ) )
  ( INSTANCE-VARIABLE ( diameter NIL ) ) )
( ASSOCIATION ball_bearing ( shaft_1 bearing ) ) *6
( ASSOCIATION bolt ( block_1 set_bolt ) ( shaft_1 push_head ) ) *7
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Figure 8. 'Class scripts for joining machinery assembly

8. Conclusions

Applying Framed Knowledge Base to a scheme of machinery assembly is realistic and as seemingly, the statement of 'Association which is very much extraordinary to the Artificial Intelligence in search engine implemented with Framed Knowledge Base. Retrieval there shall imply the physical meanings prevailing between two members among the assembly. Therefore, once a specific fabrication of the assembly is specified for query, every component assembled to it and their physical attachment at the interface are retrievable instantly upon request. Other form of fabrication such as welding, is also conceivable in the 'Association. Building the Fig. 8 is pretty straightforward relying on the actual arrangement of machinery parts and approximately proportional to that of the physical dimensions. Contrasted with scripts for an accustomed relational database, our methodology for the Framed Knowledge Base is superior in the way of intricacy and susceptibility for building query system for a machinery problem interrogation.

Acknowledgement

Thanks should go to the graduate school of information and computer science department at Osaka Electro-communication university , where most of our works have been done along with their joint research collaboration scheme.

9. References

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