

A Study for Smart Vocational Skill Training Based on Knowledge Graph

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Abstract—In view of the low efficiency, optimization difficulties and uncertain training effect in the process of vocational skill training, this paper studies smart vocational training based on knowledge graph. According to the needs of vocational skills training, the system creates knowledge graph objects by natural language processing automatically, then utilizes ant colony algorithm to discover the path of knowledge graph, and finally develops the training plan. The vocational skill training is designed and developed in Python language.

Keywords—Vocational skill training; Knowledge graph; Ant colony algorithm; Python

I. INTRODUCTION

Vocational Competition [1] is important for improving vocational skills and the quality of teaching and training. The basic purpose of Vocational Competition is to promote teach and compete interactively. For a long time, vocational colleges and universities have been enthusiastic about participating in and winning prizes in competitions. They have invested a lot of manpower and material resources and achieved excellent results. However, due to the shortage of teachers and limited energy, the impact of the contest has not been able to play a point-by-point and side-by-side role in expanding the impact. There are two reasons for this:

(1)Time constraints: Teachers and students use their normal spare time after work for guidance and training, all their energy is focused on how to improve their skills and win awards; there is no time to record, analyze and optimize the training process.

(2)Timeliness: Although instructors have rich experience in the training process, they may suddenly forget some details after a high-intensity competition. In the subsequent work summary, it is easy to overlook some potential key points.

In order to achieve the goal of scientific guidance, problem discovery, efficiency improvement, breakthroughs and innovative demonstration in the process of vocational skills training. It is difficult to make substantial progress by relying solely on the hard and diligent work of teachers and students.

Nowadays, scientific training has achieved great results and breakthroughs in the field of skill training. For example, in the Olympic Games Track and Field, Swimming, Badminton and so on. These scientific training methods are

often mastered by the coaching group, and it is difficult for a

vocational teacher to guide the skills training of multiple students effectively.

Smart/Intelligent training technology is mainly developed for specific application requirements. When the application scenario changes, it is customized by professional software developers. Because of the high cost of development, it is difficult for many schools and teachers to match specific individual competitions. Secondly, once the system is developed, it is difficult to modify training system according to needs and experience of users.

Therefore, the main trend of the development of intelligent training system is establishing a unified information system model for smart/intelligent training system, and making use of the experience in competition guidance, and develop training plans by using artificial intelligence searching technology.

(1) Semantic: A large amount of information in the running process of intelligent training system exists in the form of readable text. In addition, expert knowledge and experience knowledge exist in the form of semantics in human-computer interaction. Therefore, the information model should support natural language semantics.

(2) Visualization: The training plan is displayed in the form of a chart for easy implementation.

(3) Real-time updating of parameters: the weighted coefficients in the smart training system can be real time updated to avoid training plan errors caused by inaccurate parameters.

(4) Intelligence: Use machine learning and artificial intelligence to developing the best training plan.

II. VOCATIONAL COMPETITION ORGANIZATION

The organizational process [2] for a Vocational Competition includes the establishment of the organizing committee, the determination of the competition outline, the determination of scoring standards, basic skills training, training schedule, training plan formulation, training plan implementation, competition and other processes.

Most of the above processes are formulated by the participating teams according to their experience. In order to improve the training efficiency of competition skills, it is a feasible way to use intelligent training system to assist the

competition guidance process. Intelligent training system first establishes the information model of training process, uses expert knowledge and artificial intelligence technology to infer the information model, and finds the optimal training path. After the training plan is checked, the training resource bank is searched and the arrangement of teachers, venues and equipment is completed.

At present, intelligent training system has been applied in other fields [3]. Such as the use of intelligent training system for nursing professional skills training [4], the use of intelligent training system for hotel management professional skills training.

III. VOCATIONAL SKILL TRAINING SYSTEM BASED ON KNOWLEDGE GRAPH

The intelligent skill training system based on knowledge graph includes 4 steps: information system modeling, knowledge graph(KG) [5] generation, knowledge graph path discovery and training plan generation.

A. Information System Modeling for Skills Development

1) Student Information

In addition to basic personal information, grasping of relevant basic skills, relevant competition skills, starting training time, available time the more critical information is essential for skill training.

2) Competition Outline

The Competition Outline defines the contest content and the steps of each Competition content. There exist a logical relationship between competition content and training plan. For example, competition content N corresponds to training plan arrangement content M, and there is a temporal relationship between training plan content.

3) Scoring Standard

The scoring criteria give the quantitative criteria for the requirements of various competitions, such as starting scoring, adding points and deducting points. In the process of training, it is an important task to improve the level of competition to carry out targeted training for adding and deducting points.

4) Training Resource

The training resource database contains information about teachers, venues and equipment. Teacher information includes basic information, content information and available time of an instructor. Site/equipment information includes the type of equipment required, the number of equipment and the available time of equipment. From the perspective of information system, the information involved in vocational skills training can be divided into three categories:

(1) Numeric information: quantifiable information, such as scores, credits, competition score information, time, etc.

(2) Text information: Competition outline and scoring criteria usually exist in the form of documents.

(3) Experience information: teacher's experience, training experience, competition experience, etc.

B. Training Plans Generation and Verification

1) Initialization of Knowledge Graph

The initialization process of knowledge graph is as follows:

a. According to course achievements and knowledge points, initialize the knowledge graph of students.

b. Setting competition goals in the knowledge graph, such as the level of skills.

c. Setting active nodes in knowledge graph. The active node receives input from the training process and enters the next knowledge point when the active node's state value reaches the threshold. The active node can also be regarded as the knowledge point which is need to be strengthen. During a period of time after the completion of the learning, the state value of the node will reduce and need to be re-studied. Forgetting models for different knowledge points can be set up and different training processes have different weight.

2) Searching in Knowledge graph and Training Plan Generation

Based on the knowledge points grasped by a student or knowledge graph initial state, and take the available instructor time and training site into consideration, Knowledge Graph Searching process, can select the training content for the next step.

During the process of class learning, students have established their own professional knowledge graph, which is corresponding to the regulated contents from major training plan, curriculum outline and teaching plan for courses. However, Competition knowledge graph is the content of the competition, and Professional knowledge emphasizes the cultivation of professional skills, and competition emphasizes competition skills.

There may exist an incomplete one-to-one correspondence between professional skills and competition skills. Competition skills can find support points for the map of professional skills, but there are also knowledge points which are not included in the map of professional skills. We can encounter the problem of different terminology occasionally.

Therefore, it is necessary to transform the competition knowledge graph to the equivalent professional knowledge graph. The transformed competition graph is a subset of professional knowledge graph.

The intersection between the student state knowledge sub-graph and competition knowledge graph may be empty intersection, small intersection, increasing intersection, totally equivalent. When a skill training process is finished, the student knowledge sub-graph is approximately equal to the competition sub-graph.

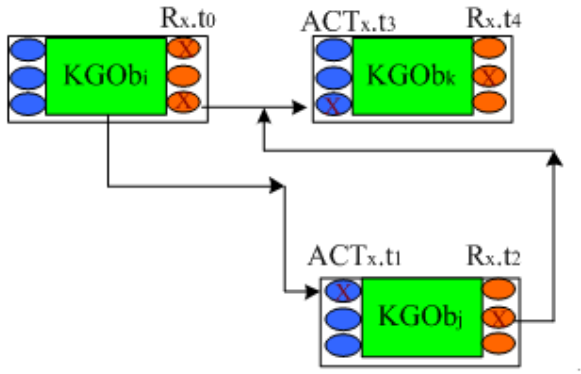


Fig. 1. A Knowledge Graph with 3 Objects

Figure 1 shows a knowledge graph consisting of 3 KG objects. For knowledge graph object $KGOB_i$, $KGOB_i.R_x(t_0)$ indicate that its current state is $R_x(t_0)$, and time stamp is t_0 . When $KGOB_i.R_x(t_0)$ meets the activate condition of $KGOB_j$ action, which is noted by $KGOB_j.ACT_x$ in this paper, $KGOB_j.ACT_x(t_1)$ will be activated at t_1 . The trigger of $KGOB_j.ACT_x(t_1)$ will produce a new result $KGOB_j.R_x(t_2)$.

If $KGOB_i.R_x(t_0)$ and $KGOB_j.R_x(t_2)$ satisfy the condition for $KGOB_k.ACT_x$, $KGOB_k.ACT_x(t_3)$ will be activated at t_3 and get new result $KGOB_k.R_x(t_4)$.

Where $t_0 < t_1 < t_2 < t_3 < t_4$ are time information of knowledge graph. By adjusting $T_j = t_2 - t_1$, $T_k = t_4 - t_3$, time cost of skill training can be taken into consideration.

Since vocational skill training knowledge graph has hundreds and thousands of object, the training plan is expressed by knowledge graph path. The generation of Training plan is a process, which is started from current object $KGOB_i.R_x(t_0)$ to a target object $KGOB_j.R_x(t_0 + \Delta T)$. It can be expressed by equation (1),

$$\begin{aligned} &P(KGOB_i.ACT_x(t_0), KGOB_j.ACT(t_0 + \Delta T)) \\ &= [KGOB_i.ACT_x(t_0), KGOB_j.ACT_x(t_0 + \Delta T_1), \\ &KGOB_j.ACT_x(t_0 + \Delta T_2), \dots, \\ &KGOB_j.ACT_x(t_0 + \Delta T_n), KGOB_j.ACT_x(t_n)] \end{aligned} \quad (1)$$

A training plan can be generated by network searching algorithms, such as ant colony algorithm for path discovery and optimization. As shown in Figure 2, a knowledge graph

network is used to find the path from the source node to the destination node.

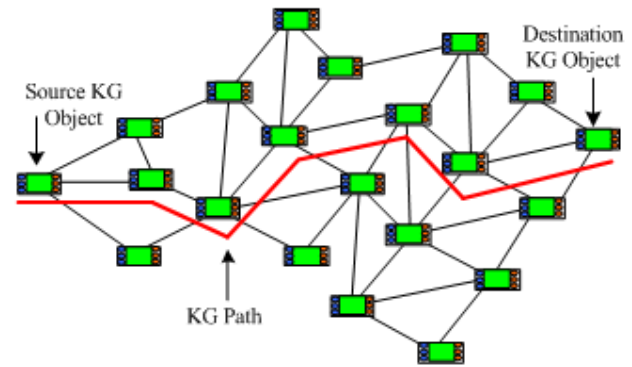


Fig. 2. Knowledge Graph Path finding for Vocational skills Training Plan

During the searching process of training plan, time and personnel conditions can be considered as constraints, such as the timetable of students and teachers. For example, and the time-constrained points are selected among neighbor nodes.

3) Training Quality Assessment

For normal training process, after the completion of a training step and a simple assessment, student will enter the next step of training plan.

However, in order to achieve acceptable results. The training effect needs to be considered. Although all the training steps have been completed, the quality of the whole training process has not met the requirements of the competition. So training quality evaluation is also an important part of training plan.

In this paper, Knowledge graph Weights can be defined by $KGOB_i.R_x(t_0)$, and the value is equal to the score obtained from a test or assessment for a training step. The assessment result is the weighted sum of the training plan.

The weight of knowledge graph can be defined and set dynamically by program. When the weight changes, the dynamic process of the whole knowledge graph will change.

4) Training Plan Implementation TimeTable

A training plan can be simplified to a series of Action, as shown is equation 2:

$$\begin{aligned} &[ACT_x(t_0), ACT_x(t_0 + \Delta T_1), ACT_x(t_0 + \Delta T_2), \dots, \\ &ACT_x(t_0 + \Delta T_n), ACT_x(t_n)] \end{aligned} \quad (2)$$

where $\Delta T_n \in [T_{avi1}, T_{avi2}]$, T_{avi1} , T_{avi2} upper and lower limits of available time.

Since the path searched by ant colony algorithm[6] contains time information for training plan. According to the time information, Gantt scheme is automatically generated. It is convenient for users.

IV. SYSTEM DEVELOPMENT SCHEME

Smart vocational skill training system based on knowledge graph includes natural language processing(NLP), knowledge graph creation, intelligent searching algorithm, network interface, HMI and other modules.

Natural language processing module is used to complete the relevant text processing functions, such as word segmentation, part-of-speech tagging, word frequency statistics for training outline, competition outline, training plan. Natural language processing module, can reduce the time consumption of creating knowledge graph .

The knowledge graph creation module defines the requirements of smart vocational skills training firstly. Then establishes knowledge graph objects, and connects knowledge graph objects with object actions, according to the text.

Intelligent searching algorithm finds the optimal path from source knowledge graph object to destination object. At the same time, the intelligent searching algorithm can be used to verify the knowledge graph and discover the possible erroneous knowledge in the knowledge graph.

The network interface is used to search database, and obtain the information of student, teacher, site and equipments. In this system, network crawler function is not essential.

HMI can be used to input expert information to construct , and verify knowledge map, and modify training plan outputed by smart training system. Making full use of expert knowledge, efficiency can be improve and the requirements and costs for artificial intelligence algorithms can be decreased. The system structure block diagram is shown in Figure 3.

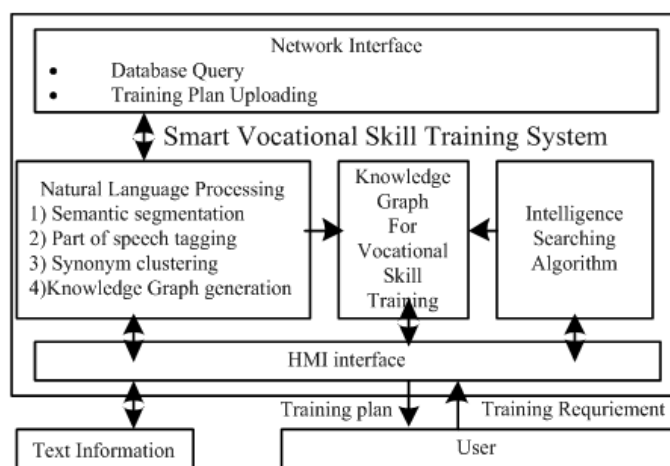


Fig. 3. System Scheme for Smart Vocational Skill Training

The development of this system is based on Python language. By importing Python natural language processing module, knowledge graph module, ant colony algorithm module, HMI module and database module, the system integration and development are completed.

V. CONCLUSION

This paper discussed the problem of vocational skill training, presented a smart vocational skill training system based on knowledge graph and intelligent searching algorithm.

The training system takes vocational competition organization, skill training, teachers, venues and equipment into consideration and automatically generates training plan.

By using of natural language understanding, knowledge graph can be automatically generated, which greatly facilitates the use of knowledge graph. Knowledge graph object method $s\ ACT(.)$ and attributes $R(.)$ are added to the knowledge graph objects. The trigger conditions of $ACT(.)$ are controlled by $R(.)$. At the same time, the time and time consumption of $ACT(.)$ are included in the knowledge graph by parameter t , which makes the knowledge map can process dynamic simulation characteristics.

The software architecture of smart skill training system includes natural language processing module, knowledge graph of vocational skill training, intelligent searching algorithm, network interface module. The training system is developed by Python language.

Therefore, the vocational skill training system proposed in this paper can satisfy the need of vocational skill training and competition training. It has promising technical and economic value.

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