Similarity of Learners' Understanding Type Classified by SOM on Intellectual-Property Education

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***Abstract*—** In the past researches, we have attempted to support intellectual-property (IP) education by an on-demanded e-Learning system that has recommended learning contents suitable for a learner. The recommendation has decided by the estimation results of the type of the learners' understanding. In this paper, the types are calculated by learners' correct answers' ratio of online test. We also examine a similarity of learners' understanding type classified by Self-Organization Map (SOM).

With the classification results, we also calculate the similarity of each types. Based on the similarity, we can recommend more suitable contents to the learner classified to the similar type. Further research on this type of learning support system would contribute to development of the recommender system on IP education.

***Index Terms*—** e-learning, self-organization map, learning support, intellectual-property education

I. Introduction

There have been many developments on learning support system that recommend suitable learning contents for learners [1]-[6]. These systems are designed to be intelligent in analyzing learners' understanding.

In the past researches, we developed a learning-support system with a classification function that can classify learners' understanding into six types using results of online test [3], [4], [5] and [6]. The proposed system consists of three functions: examination of online test using categorized questions, measurement of learner's four academic skills and classification of learner's understanding type to recommend suitable learning contents for the learner. According to these types, the system recommended the suitable learning contents for the learner automatically. In addition, we inspected the usefulness of the proposed system in the lecture of the real network technology [3] and [4]. We also showed the system could be applicable on the law education [4] and the usefulness of the quiz application to estimate the learners' understanding on IP education [5], [6]. We have also proposed the e-learning system that measures academic skills of learners and estimates the type of learners' understanding using SOM classifier. Since the SOM is an unsupervised classifier, we can classify learners automatically [6].

In this paper, we examine the classification results by SOM and calculate the similarity of each types of learners' understanding.

TABLE I: Explanation of Learner's Type

Category		Explanation
1	Master	Learner who achieved excellent results.
2	Adept	Learner who acquired basic knowledge but was not good at the thinking.
3	Careless	Learner who acquired basic knowledge but was not good at the judgement.
4	Apprentice	Learner who memorized the meaning of the legal terms.
5	Neophyte	Learner who started learning.
6	Others	

TABLE II: Summary of Online Course

	Explanation
Course Name	Local contents and Intellectual Property Management
Learning Style	on-demand e-Learning
No. of Learners	199
No. of Questions	30
	Terms: 3, Purposes: 6, Requirements: 4, Applications: 8, Proceedings: 7, Descriptions: 2

TABLE III: Number of Training Data for Each Types

Type i	1	2	3	4	5	6
Total No. of Data S_i	81	76	15	11	9	7

TABLE IV: Similarity s_{IJ} of Each Types of Learners' Understanding

Classification Results of Type j	Training Data of Type i					
	1	2	3	4	5	6
1	0.96	0.03	0.07	0.00	0.00	0.00
2	0.02	0.91	0.27	0.09	0.00	0.00
3	0.01	0.05	0.53	0.09	0.00	0.00
4	0.00	0.01	0.13	0.64	0.22	0.00
5	0.00	0.00	0.00	0.18	0.78	0.00
6	0.00	0.00	0.00	0.00	0.00	1.00

II. Experimental Results and Discussion

A. Type of Learners' Understanding

We defined six types of learners' understanding in Table I. The type is classified to six categories: Master, Apprentice, Adept, Careless, Neophyte and Others. The proposed system was implemented in an introductory course of on-demand e-Learning at five universities in Japan. The summary of the online course is illustrated in Table II. The number of learners is 199 and that of questions is 30 [5], [6].

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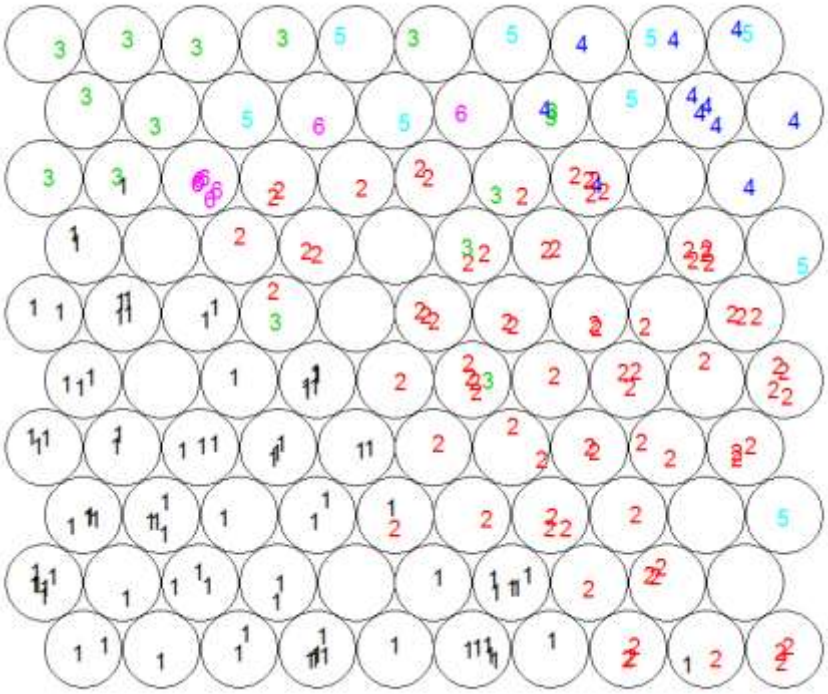

Fig. 1. Distribution of Learners' Understanding Type Classified by SOM.

Classification of Learners by SOM

Table III shows the number of training data and the calculated similarity of the each types are illustrated in Table IV. We count the number of learners in the each units of competitive layer of the SOM illustrated in Figure 1. The similarity s_{ij} that illustrated in Table III is calculated by equation (1). n_{ij} means a training data of type i is mapped on a unit that a training data of type j is mapped, too. S_i that is illustrated in Table II means the total number of the training data categorized in type i.

$$s_{ij} = \frac{n_{ij}}{S_i} \tag{1}$$

For example, in the case of a training data of type 1 are mapped on a unit that a training data of type 2 is mapped, too, the similarity s_{12} is calculated by equation (2).

$$s_{12} = \frac{n_{12}}{S_1} = \frac{1}{81} = 0.02 \tag{2}$$

III. Conclusion and Future Work

In this paper, we examined the similarity of the type of learners' understanding classified by SOM classifier. The results show the characteristics of type 1, 2 and 6 are well extracted compared to other three types. But those of type 3, 4 and 5 are not extracted. Therefore, we need to divide the different types of learners classify in the same unit when we recommend the learning contents suitable to the learner.

References

[1] B. Bert, M. Bruce, M., and B. Gautam, "Guest Editorial: Special Section on Learning Systems for Science and Technology Education," *IEEE Trans. Learn. Technol.*, vol. 6, no. 3, pp. 194–196, 2013. http://dx.doi.org/10.1109/TLT.2013.30

[2] T. Hsu, C. Chiou, J. C. R. Tseng, and G. Hwang, "Development and Evaluation of an Active Learning Support System for Context-Aware Ubiquitous Learning," *Learn. Technol. IEEE Trans.*, vol. 9, no. 1, pp. 37–45, 2016. http://dx.doi.org/10.1109/TLT.2015.2439683

[3] H. Murai and H. Okumura, "Assistance of Comprehension by e-Learning," *Journal of the educational application of information*, vol. 7, no. 1, pp. 31-35, 2004. [published in Japanese]

[4] H. Murai, "Intellectual Property Learning System Supported by SOM," *IEICE Technical Report of NLP*, vol. 105, no. 547, pp. 113-116, 2006. [published in Japanese]

[5] H. Murai, T. Hayashi, R. Yaegashi, K. Fujimoto and N. Gotoda, "A Study of Classification of Quizzes on Intellectual-Property Education", *Int'l Journal of Computing, Communications & Instrumentation Eng. (IJCCIE)*, vol. 3, no. 1, pp. 123-124, 2016. http://dx.doi.org/10.15242/IJCCIE.AE01160012

[6] H. Murai, T. Hayashi, R. Yaegashi, K. Fujimoto and N. Gotoda, "A Study of Estimation of Learners' Understanding on Intellectual Property using Categorized Questions", *Int'l Journal of Computing, Communications & Instrumentation Eng. (IJCCIE)*, vol. 3, no. 2, pp. 342-345, 2016. http://dx.doi.org/10.15242/IJCCIE.AE0616107