Research on students' classroom behavior based on big data analysis and hidden Markov model

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Abstract. Under the traditional mode of classroom teaching, there is a problem that students' classroom behaviours are inconsistent with their classroom results. In view of the above problems, this paper analyses students' classroom behaviours through big data, and gives a hidden Markov model. The model can establish the organic relationship between classroom behaviours and students' results, and adjust the contents that affect classroom behaviours in real time in the process of teaching. The results show that the model is effective, and big data analysis plays an important role in the analysis of curriculum behaviours.

1. Introduction

How teachers view their students may have a significant impact on their future educational achievements and trajectories [1]. Do teachers see students as young people who need to be cultivated and motivated, or as troublemakers who need to be controlled and controlled? Teachers' views on students will affect the frequency of encouragement or the conclusion they give to students. When a teacher gives a high evaluation to a student, for example, often encourages and supports the student, the student may be more active and eager to learn in class. In 1968, Pygmalion in the classroom by Rosenthal and Jacobson is the first study to systematically focus on Teachers' cognition and its influence on their behaviours in the classroom [2]. They showed that students performed better when teachers had higher expectations of them. This has triggered a decades long debate about the impact of teachers' classroom behaviours and expectations, followed by many studies concluded that teachers' classroom behaviours and expectations affect students' academic classroom behaviours and performance. Although Rosenthal and Jacobson focused on the impact of teachers' classroom behaviours on students' performance, others asked how teachers' classroom behaviours and expectations were formed. More specifically, one study examined the extent to which teachers' perceptions of students' classroom characteristics differ; these differences still exist even when actual performance differences are controlled [3].

This kind of research finds that there is indeed a connection between teachers' classroom behaviours and students' classroom behaviours, which makes people doubt whether students are treated the same way. Previous studies on teacher K mainly focused on Teachers' cognition or expectation of students' achievement. In the current research, we think that this cannot fully reflect the teachers' views on students. In addition to paying attention to students' learning skills, teachers can also consider students' enthusiasm and their performance in class when judging students' performance [4]. In particular, students' interest in the classroom, compliance with classroom rules or willingness to
devote energy to doing homework may affect the teacher's view of the student when it is impossible to simply calculate the number of correct answers (i.e. thesis, oral presentation). This in turn may affect the daily interaction between students and teachers, and may even affect teachers' views on students' performance. However, there are few studies on Teachers' perception of students' motivation or classroom behaviours \([5]\).

The purpose of this study is to explore teachers' cognition of students' classroom behaviours. We find that teachers' cognition of students' learning motivation and classroom behaviours is related to teachers' perception of students' characteristics and cognitive skills\([6]\).

2. Hidden Markov Model (HMM)

Hidden Markov model is widely used in probabilistic structure modelling with potential variables\([8]\). It is an alternative to the classical hidden Markov model, which is used to reveal the Markov dependence between the current and previous binary information. The main assumption of hidden Markov model is that observation symbols are conditionally independent and identically distributed random variables. In some cases, this assumption may be invalid in practice. That is, the observation symbol appearing in the current state may depend on the previous observation symbol appearing in the previous state. In this paper, a class behaviours model based on Hidden Markov model is proposed, in which the current pair of hidden state emission observation symbols and the previous pair of hidden state emission observation symbols have first-order Markov dependence. The proposed model can capture the possible first-order Markov dependence between the last step and the previous step. In addition, if the observation symbol is conditionally dependent, it provides a better representation for appropriate practical problems. Suppose \(V\) is the set of all possible observations and its number is \(m\), \(Q\) is the set of all possible state values and its number is \(n\), as shown in formula (1).

\[
V = \{v_0, v_1, \ldots, v_{m-1}\} \\
Q = \{q_0, q_1, \ldots, q_{m-1}\} \tag{1}
\]

Suppose that the length of the sequence is \(t\) (that is, there are \(t\) moments), \(O\) is the observation sequence and \(H\) is the state sequence, then it is shown in equation (2).

\[
O = \{o_0, o_1, \ldots, o_{m-1}\} \\
H = \{h_0, h_1, \ldots, h_{m-1}\} \tag{2}
\]

Suppose that the sequence length is \(t\), \(O\) is the observation sequence and \(H\) is the state sequence. The HMM model is shown in Figure 1.
Next, we will make two hypotheses, one is homogeneous Markov hypothesis, the other is observation independence hypothesis.

There is a state transition probability matrix $A$ from time $T-1$ to time $t$, as shown in equation (3).

$$a_{ij} = P(H_t = q_j | H_{t-1} = q_i)$$
$$A = [a_{ij}]_{N \times N}$$ (3)

Let $O_t = v_k, H_t = q_j$. $b_j(k)$ be the emission probability, and the emission matrix $B$ describe the relationship, as shown in equation (4).

$$b_j(k) = P(O_t = v_k | H_t = q_i)$$
$$B = [b_j(k)]_{M \times M}$$ (4)

In addition, in the initial time, since there is no pre order time, the observation and hidden state at the initial time cannot be known from the dependency relationship, which needs to be defined by the hidden state distribution $\pi$, as shown in equation (5).

$$\pi(i) = P(H_1 = q_i)$$
$$\Pi = [\pi(i)]_n$$ (5)

To sum up, there are three parameters in HMM model, as shown in equation (6).

$$HMM = (A, B, \Pi)$$ (6)

3. Methodology

In this paper, the author proposed model base on big data of students' classroom behaviours from HMM, as shown in Figure 2.

4. Experiments

In this section, we evaluate the effectiveness of proposed method base on big data of students' classroom behaviours from HMM. The experiment results indicate that our method is capable of improving the Students’ classroom quality.

In this paper, the student results are divided into five states, such as excellent (E), good (G), average ( Avg ), pass ( Ps ), failed ( Fa ).
Students' classroom behaviours (SCB) is divided into nine situations, such as whether to preview, whether to attend class, whether to finish homework, whether to discuss and answer questions, and whether to play truant. In this paper, the relationship between classroom behaviours and students' classroom conclusion is established.

According to the classroom behaviours prediction and the actual situation, as shown in the figure 4. It shows that some positive measures have been taken in class to improve the enthusiasm of the students.
Under the condition of big data analysis, timely adjustment of these positive measures will help to improve the efficiency of classroom learning. This shows that the introduction of big data in the classroom is conducive to improving the achievement of the course.

Figure 5. Forecast results and Forecast results Using HMM

Forecast results using HMM is better than Forecast results, as shown as in the figure 5.

5. Conclusion
In view of the traditional mode of classroom teaching, this paper uses big data analysis. The proposed model analyses students' classroom behaviours, such as preview, listening, question and answer, and after class exercises. For big data analysis, timely adjustment of classroom teaching behaviour is helpful to continuously improve the quality of teaching.

However, there are still some important factors not considered in this paper, such as the quality of preview and so on. In the future work, we should continue to consider these factors using the neural Networks\(^9\).

6. Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments
This work is supported by the Scientific Research Funds project of Science and Technology Department of Sichuan Province (No. 2016JY0244, 2017JQ00059, 2019GFW131, 2020JY, 2020GFW), Funds Project of Chengdu Science and Technology Bureau (No. 2017-RK00-00026-ZF), the National Natural Science Foundation of China (No. 61902324), the Fund of Sichuan Educational Committee (17ZA0360), the Foundation of Cyberspace Security Key Laboratory of Sichuan Higher Education Institutions (No.sjzz2016-73) and Sichuan Youth Science and technology innovation research team (2021).

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