A Scientific Research Ability Prompting Approach in the Teaching of the Machine Learning Curriculum

Bing-juan ZHAO¹ and Xue-qiang ZENG¹,a,*

¹College of Information Engineering, Nanchang University, Nanchang, 330031, China.
*aEmail: xqzeng@ncu.edu.cn
*Corresponding author

Keywords: Machine learning, Scientific research ability, Teaching reform, Degrees and postgraduate education.

Abstract. The teaching method of machine learning has a significant influence on the promotion of students' research ability. In traditional machine learning curriculum teaching, students have low interest in the theoretical study and lack practical ability of scientific research. It is particularly important to reform the teaching of machine learning to stimulate students' interest in the study, and to cultivate their comprehensive research ability. In this paper, we propose the idea of using exploring education to improve students' scientific research capability. Traditional teaching mode was transformed into an interactive teaching mode by using the methods of interactive teaching and case-teaching. In our practical teaching, our method obviously improved the teaching effect and got positive responses from participated students.

Introduction

Machine learning is not only a hot theoretical research field in artificial intelligence but also a high practical demanded technique, which is a combination of statistics mathematics, information science, brain science, cognitive science and many other disciplines. The teaching of machine learning curriculum aims to cultivate students with the capability of designing computer programs for innovation, which will meet the machine automatically and improve the performance of autonomous learning knowledge [1].

Machine learning features profound theories, abstract concepts and relatively independent chapters, which leads to the difficult course and the few arrangements for curriculum experiments. The primary task of Machine learning course education is to stimulate students' interest in teaching, develop students' ability to comprehensive innovation and learn this course well, this is also an important and challenging problem in teaching [2], [3]. Based on two years of machine learning series analysis of course construction, this paper analyzes the opening of related courses at home and abroad. In order to summarize the experience of teaching reform, this essay's analysis is based on course concept, content, mode and measures, which will be applied to machine learning in the teaching process.
The Problems Existing in the Traditional Teaching

The problems existing in the theoretical teaching

The course of machine learning is quite theoretical and hard for students to understand. The traditional teaching method involves the explanation of various theories and algorithms of machine learning in the classroom as well as many math formulation derivations. This situation puts forward higher requirements for the reading ability foundation in Math of the students. Thus the students who are not good at math easily get bored and lose interest in study. The machine learning course is so abstract and full of a large number of knowledge that the students may find it hard to master, especially the distributed knowledge points. Many students still can't use it in practice even though they have mastered the knowledge, which greatly affects the study enthusiasm of students. For the traditional theoretical classes of machine learning where teachers generally teach theories and algorithms of machine learning in normal way and most students passively learn those theories. It is difficult to stimulate students’ interest in learning and cultivate the ability of discovering and solving problems. Hence, it cannot significantly improve the postgraduates' scientific research ability.

The Problems Existing In the Experimental Teaching

Machine learning is a subject of training students’ creativity and practical abilities in school education. However, the current course setting of postgraduate education is lack of forward looking and innovation. The content of course is aged and the teaching method is humdrum. Students do not have the experimental class, and they can only rely on their own after class due to the lack of communication with teachers and classmates. When meeting a question, it cannot be solved in time. If this does take place, it will not meet our deployment targets of deepening the theoretical knowledge and culture their practical ability. Because students cannot master course related programming language tools, this makes students cannot complete the experiment freely using the programming tool and causes students to practice procedures for the preparation with the conflict and fear for the complex machine learning algorithm and more difficult programming. Therefore, it is not conducive to the students’ practical ability training and acceptance of the theoretical knowledge.

The Detail Teaching Reform Techniques

To solve the above problems, this paper focuses on the improvement of the theoretical teaching and practical teaching in machine learning in the teaching reform, concentrating on how to organize teaching contents, improve teaching method and the innovation of teaching ideas and teaching mode. It aims to stimulate student's study interest and promote students researching ability to achieve the effective union of cultivation of knowledge and ability of scientific research.

Improvement of Teaching Theory Content

As a comprehensive field of crossing multi-subject, machine learning involved many subjects such as Statistics, artificial intelligence, information theory, philosophy, biology, cognitive science, computational complexity and control theory and other disciplines of knowledge etc. The machine learning is a theoretical course, covering too much complex classification. Therefore the establishment of a scientific system of
teaching content is to enrich the teaching content and improve the teaching effect and students' scientific research quality.

In the teaching process, we chose the Stanford University machine learning open course content curriculum and teaching materials, teaching content of the right to choose adjusted refining and processing, the appropriate effective outreach. Such as: a Bayesian decision probability, the Fisher linear discriminant analysis linear decision and piecewise linear distance classifier, feature extraction and selection of principal component analysis (PCA) and independent component analysis (ICA) and the corresponding method based on kernel function, K-means algorithm, Pattern recognition of support vector machine (SVM), regression estimation, probability density estimation and so on. The teacher should explain these contents. With the help of matlab, it has a strong visual function, and the results are showed directly and clearly through graphics, curve, animation, etc with particular attention focused on the use of a variety of chart to each knowledge point together. The derivation process of specific mathematical formulas of desalination, and focus on the introduction of a new theory and method of the course to ensure the relatively stable and continuously updated teaching content. Through the analysis of theories and concepts, students not only learn knowledge, but also learn and analysis of the problem.

The increase in close contact with the practical application of the contents, such as video object recognition and tracking, spam detection and face recognition fosters students’ interest and evokes their enthusiasm towards the Machine learning course. In the process of teaching, the proper use of case teaching model, which combines the basic teaching content with the basic knowledge, improves the ability of practice and innovation.

Machine learning is of strong theory, as it involves a large number of mathematical formulas over the course of various theory and algorithms. In many cases, complicated mathematics derivation makes students lose interest in learning. In order to strengthen the teaching effect, to simplify the process of mathmatic inference process and to refine the main steps of mathematical derivation, the teacher should lay stress on lecturing the results and showing the significance of mathematical physics in the classroom teaching. It is using a variety of machine learning methods to solve the core idea of specific machine learning problems.

**Teaching Objectives and Teaching Idea Reform**

Teachers' teaching ideas have direct influence on the teaching quality of this course. The innovation of the teaching goal and the teaching idea must be based on student-centered, and promote the development of the subject. In particular, it can be started from several aspects.

On the innovation of teaching objective, the aim is usually to cultivate of students’ scientific research, innovate abilities, focus on clarifying the concept and highlight the application. Materials are based on the data of the open class of machine learning in Stanford University, using foreign classical works "an introduction to machine learning," and "data mining - a practical machine learning technology and machine learning related data as auxiliary material. It mainly discusses the machine learning in statistics, pattern recognition, neural networks, artificial intelligence, signal processing and different areas of application, in practice, With classification and regression machine learning task two as a template and ten classic machine learning algorithm as core,[4] the content is designed with simplification and integration and the experiment outline and teaching textbook is compiled.
To improve the students' ability of practice and thinking, we set up some small tasks in the teaching process, whose aim is to increase the students' ability of analyze and practice the pattern recognition. The students are divided into different groups; each group was assigned a different subject topic, such as "face detection", "license plate recognition", "Texture Detection" and so on. We require students to organize research group after class, discuss and analyze the new problems. By putting forward their own views, students discuss the methods to solve the problem, complete the research report within the prescribed time, select the task group on behalf of students to go on the platform about research, and introduces the research results. The results show this teaching method not only improves the students' interest in learning, but also enhances the students' scientific research analysis and practical ability. Scientific research project discussion from the independent inquiry, the scientific research group exchanges to show their ideas, and so forth, and each step can strengthen the training and training of research ability of graduate students. Discussion is a process in which a variety of academic thoughts are exchanged, which is helpful for students to absorb other’s thought, result in new ideas, improve the quality of scientific research of graduate students, give full play to the postgraduate students' initiative and participation of a variety of teaching mode, and cultivate research postgraduate scientific research ability.

For the cultivation and training of the creative thinking, students have an important role [5].

In the innovation of teaching philosophy, the teacher's teaching idea transformed from subject-oriented teaching to the inquiry teaching of cultivating the students' scientific research ability. Teachers used to focus on knowledge imparting and heavy teaching indoctrination, ignoring the cultivation of ability and the guidance of learning method. Now the practice of education mode is emphasized as the teacher guides the student step by step so that students and teachers work together to complete the teaching requirements and cultivate the students' scientific research and innovation ability. For example, in the teaching of decision tree method, the classification model should have the structure form of the application background, and then lead to the decision tree algorithm. The construction of the model is a recursive process: the first step is to select an attribute for the root node, for each possible attribute values produce a branch and this process is repeated recursively on per branch. Then recursive construction problems encountered in the process of the decision tree are presented and discussed: How to stop the tree expansion? How to judge which attribute should be split? The third step is to lead the information quantity, information gain and other related concepts and calculation process. Because students do not have information on the background knowledge about "entropy" concept, formula and calculation method of understanding, it is proper for the students to finish and write study report after class.

Through a variety of ways and means to cultivate students' learning interest, teachers also need to accurately grasp the positive factors in teaching and students' learning initiative, changing students' learning styles fundamentally. Teachers should find ways to inspire students to express their views on specific issues, and guide students to take the initiative and acquire knowledge actively and consciously. Through the design of the problem - to provide information - inspired ideas - Interactive - draw the conclusion of the steps to understand and master the basic idea of machine learning methods.

**Teaching Mode and Teaching Method Improvement**

The cultivation of scientific research ability and innovation ability should be based on reasonable knowledge structure, but it is not a one-way knowledge infusion. The
In the teaching activity of graduate students is oriented from the academic research. So the exploratory teaching method should be the main way of the post-graduate education. In this paper, the following aspects are analyzed in depth.

In the course teaching mode, we use the exploratory teaching mode. Courses are not taught in the way of infusion, but taught according to the characteristics of the course. A variety of teaching methods should be used flexibly, for example interactive seminar teaching, talking about teaching, lectures and other teaching methods [6]. In the teaching process, we adopt inquiry teaching mode. Under the guidance of teachers, students' learning style is characterized by "autonomy, inquiry and cooperation", autonomous learning of the main knowledge points in the current teaching content, further research and discussion in group, so as to better achieve a kind of teaching mode of the course objectives.

In the teaching method, we use the interactive type and the case type teaching method. Interactive teaching method is the exchange between teachers and students in the teaching process, attaining a different view of the collision blend, stimulating the initiative and exploration of teaching and further improving the teaching effect of a teaching method. By analyzing the existing cases, the Case based teaching method is to inspire students to think about the problem, deepens the knowledge of the master, and achieve a multiplier effect. The interactive teaching method and case teaching method are applied to the teaching of machine learning course, focusing on teaching content, which turns the classroom into the scene of the interactive case discussions, and improves the students 'autonomy greatly .This is helpful for the students to master the teaching content.

Interaction teaching should be paid attention. Teacher-Student Interaction is the most basic form in theory teaching. It is supposed to be an effective way to improve the efficiency of teaching and reach the teaching optimization. Therefore, the classroom teaching mode should change from the traditional teaching "cramming method of teaching" to "interactive quiz", by asking questions to guide the students to think, arouse the students' thirst for knowledge, and mobilize all positive factors of student. For example, when explaining "instance-based learning" chapter, firstly, three learning methods are introduced: k nearest neighbor algorithm, locally weighted regression and case-based reasoning, locally weighted regression and case based reasoning, then you can ask students: What these methods have in common? What is the difference with the previous method of learning? According to the student's answer, the concept of active learning and passive learning should be guided and the important differences between the two methods should be pointed out. And then ask the students: whether there is a substantial difference between the positive and negative methods in the induction bias? Efforts should be made to guide students to think about the causes of these differences and to explore the origin of the problem. Then teachers can also ask students: these differences will affect the accuracy of the generalization of the learner? Let the students further think about what kind of results these differences will lead to, so as to have a deeper understanding of the algorithm [7].

Applying the application in practical the teacher should explain the case as a lot of machine learning algorithms and formulas theory is strong, abstract and not easy to understand. If the teacher is simply based on text and formula is derived by means of teaching, this will not achieve a good teaching result. Therefore, in the theoretical teaching, we can use examples to explain, paying attention to theory and practice. For example, in the explanation of the "Bias study" chapter, there is a Naive Bayesian classifier algorithm, and the difficulty of this algorithm is to estimate the probability of
each attribute given target value. To allow students to better understand and master the algorithm, we can explore the recognition of handwritten figures in Arabia to explain.

Conclusions

The curriculum of machine learning is quite theoretical and practical course. The major goal of machine learning course of postgraduate students is to cultivate students’ scientific research abilities. It is desired to raise students’ competence of scientific research and innovation by appropriate teaching. However in traditional teaching, students have low interest and are lack of practical research ability. Hence, it is particularly important to reform the teaching way of machine learning to stimulate students, and to cultivate their comprehensive research ability.

The teaching reform is a long-term task, involving lots of practices and hard works. All aspects of the process of teaching, i.e., teaching content, teaching idea, teaching mode and method are required to be optimized or restructured to improve the final teaching quality. After analyzing the teaching theory, teaching philosophy, and teaching mode of machine learning course, the authors put forward an effective teaching reform program to stimulate students’ interest in learning and to cultivate students’ innovation ability and practice ability. Traditional teaching mode was transformed into an interactive teaching mode by using the methods of interactive teaching and case-teaching. In practices, the proposed method significantly improved the scientific research abilities of postgraduate students.

Acknowledgement

The work was supported in part by the Natural Science Foundation of China under grant no. 61463033, the Natural Science Foundation of Jiangxi Province under grant no. 20151BAB207028, and Degree and Postgraduate Education Teaching Reform Project of Jiangxi Province under grant no. JXYJG-2015-017.

References