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Teaching Research and Practice of Intelligent Optimization Algorithms under the Background of "Artificial Intelligence + X"

Zheng Li, Jinlei Qin

Department of Computer, North China Electric Power University, Baoding 071003, Hebei, China

Abstract

Based on the "Artificial Intelligence + X" compound professional talent training mode proposed by the Ministry of education, this paper focuses on the construction of knowledge system and the innovation of teaching method to the intelligent optimization algorithms course for relevant undergraduate majors. Specific solutions are proposed to some problems existing in the process of curriculum teaching, which will be beneficial to the construction of curriculum systematization from multiple angles.

Keywords

Artificial Intelligence + X; Intelligent optimization algorithms; Computational thinking; Knowledge system reconstruction.

1. Introduction

Since the Ministry of education actively promoted the construction of new engineering courses in 2017, the construction of undergraduate majors related to artificial intelligence has rapidly become one of the priorities of many universities [1-2]. In 2018, the Ministry of Education issued the Action Plan for Artificial Intelligence Innovation in Higher Colleges and Universities to further promote the construction of "New Engineering Subjects"[3]. The Action Plan pays attention to the cross integration of artificial intelligence and professional education in computer, control, mathematics, statistics, physics, biology, psychology, sociology, law and other disciplines, and a new training mode of "Artificial Intelligence + X" is formed for composite majors[4]. Since 2019, many colleges and universities have built artificial intelligence colleges or intelligent science and technology major, and the construction of professional courses has become a top priority. At the same time, courses related with artificial intelligence quickly occupy a place in the elective courses of various majors.

As an important research field of artificial intelligence, intelligent optimization algorithms solve complex optimization problems by simulating natural evolution and biological intelligence. It has become a very important course for intelligent science and technology and other majors. Under the current needs of "Artificial Intelligence + X" compound specialty training, building the knowledge structure and application framework of intelligent optimization algorithm, and striving to build the knowledge system of intelligent optimization algorithm integrating multi-disciplinary problem solving for undergraduates, those are not only conducive to consolidate the basic knowledge of intelligent computing, but also to expand the knowledge structure of students in multi-disciplinary fields.

During the teaching process, adhering to the guiding ideology of "Artificial Intelligence + X" of the Ministry of education and referring to the characteristics of multi-disciplinary problems, the single knowledge introduction of intelligent optimization algorithm is extended to the solution of complex problems in other disciplines, so as to build the curriculum teaching content of multi-disciplinary cross knowledge system and reform the traditional teaching mode. "Round Table Classroom" with the curriculum as the carrier is created to cultivate students'

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abilities of expression, communication, innovation and teamwork. On this basis, combined with the experience of online teaching, making full use of the advantages of mature online teaching platforms such as classroom school, and digging the advantages that traditional classroom teaching does not have, such as bullet screen question answering and online homework submission, will help to improve the teaching effect. Establishing a teaching mode that combines the advantages of the online and offline teaching mode will enhance the teaching effect of the teaching mode.

2. Course Objectives and Teaching Content Structure

The teaching goal of intelligent optimization and application course focuses on training students to master the idea of intelligent algorithm for solving problems, the influence of parameter setting on the solution effect and the specific process of realizing the algorithm, which all need to deeply understand the relevant knowledge in the field of the problem to be solved. Therefore, by reforming the curriculum knowledge system and taking X of "Artificial Intelligence + X" as the expansion part of students' knowledge, this will establish a new curriculum knowledge system with multi-disciplinary integration. While explaining and learning the traditional algorithm ideas, integrating more problem knowledge in more fields and designing cases in more disciplines will help students not only to master the basic idea and implementation process of intelligent algorithm, but also to enhance the computational thinking ability to solve problems.

In recent decades, many famous scientists in the world have proposed various intelligent optimization technologies and conducted in-depth research on their application fields and parameter structures. For example, in 1975, inspired by Darwin's theory of evolution, John Holland of Michigan University proposed genetic algorithm based on the process of biological evolution. In 1983, IBM physicists S. Kirkpatrick, C. D. GELAT and M. P. Vecchi invented simulated annealing algorithm, etc. Many experts have also published high-level papers in the fields of power, control, operations research and other disciplines, using intelligent optimization algorithms to solve specific problems. Under the guidance of the idea of "Artificial Intelligence + X", integrating the needs of multi-disciplinary problems and building the curriculum into a multi-disciplinary knowledge framework, and a new teaching scheme of "intelligent guidance, focusing on application" can be formulated.

3. Key Problems and Solutions Proposed in Teaching

Question 1: how can intelligent optimization technology comprehensively be introduced, and how can key points highlighted and how can reasonable cases be designed to consolidate students' mastery and application ability of algorithms under the established class hour limit.

Solution: because the professional training program has certain restrictions on the course hours, some contents in the teaching process are bound to be unavailable in the classroom. Therefore, it is necessary to sort out the knowledge points in the course and sort them according to the importance in the knowledge system and the priority of students' learning difficulty. Drawing a mind map for the whole course, those knowledge located in the backbone of the knowledge system and the contents with greater learning difficulty are planned to explain in the classroom. The expanded knowledge can be reserved for homework before or after class for students to study by themselves.

Specifically, in the course of intelligent optimization and application, the widely used intelligent algorithms including genetic algorithm, particle swarm optimization algorithm, ant colony algorithm, differential evolution, artificial neural network and other mainstream algorithms can be explained as the main content of the class at present. However, regarding fish swarm algorithm, bee colony algorithm and so on, because of the similarity to the idea of ant colony

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algorithm, they can be treated as expansion after class and reserved for self-study homework. At present, the course knowledge architecture is as follows: the concept and main classification of optimization problems which summarizing the meaning of various optimization problems from different angles; Based on the analysis of various traditional optimization methods, the development process of intelligent optimization algorithm is summarized; Several intelligent optimization algorithms are introduced from three categories: evolutionary computing, swarm intelligence and artificial neural network. Evolutionary computation is represented by genetic algorithm and differential evolutionary algorithm. The proposal, implementation process and key technologies of those two algorithms are described in detail, and application examples are given. Swarm intelligence is represented by particle swarm optimization algorithm. On the basis of expounding the principle of the algorithm, application examples can be further given, and the particle swarm optimization algorithm can be expanded in these aspects of various improvements of the algorithm and solving multi-objective optimization problems. In the part of artificial neural network, multi-layer forward neural network, radial basis function neural network, Hopfield neural network and self-organizing feature mapping neural network are introduced. Finally, a specific application example is given.

Question 2: how teach scheme can be designed and what disciplinary can be incorporated in order to achieve "Intelligent leading and focus on application"; How does teacher break through from focusing on intelligent algorithms to improving students' problem-solving ability.

Solution: The design of teaching scheme is the soul of the whole course. The explanation of intelligent algorithm is important admittedly, but the selected cases are directly related to students' feeling of the importance of the course. In some internationally renowned journals, experts have published a large number of papers on Intelligent Computing, involving problems in various fields of national economic development. During the process of teaching, scientific research should be integrated into teaching to complement and promote each other. Combining a large number of interdisciplinary papers in scientific research, absorbing the research results of many scholars, and the knowledge composition of the course can be planned. Scientific problems that have a great impact on economic and social development can be selected as cases in the course. On the basis of explaining the algorithm, closely combining with the urgent problems in important fields, the teaching scheme design can be explored to improve students' interest and problem-solving ability. For the application of mainstream algorithms in specific fields, design cases of key disciplines such as power, control and finance, which are more important in the development of national economy, can be selected to cultivate students' ability to solve specific problems. Over the past decades, scientists have made a lot of improvements to each optimization algorithm to improve the performance of the algorithm, which can be used as an extended introduction in class. The detailed implementation can be assigned for students to complete after class so as to improve students' Computational Thinking and engineering practice ability.

At present, the course teaching scheme combines intelligent algorithm with industrial production practice, and particle swarm optimization algorithm and artificial neural network are used in the examples of optimal dispatching, fault diagnosis and thermal parameter prediction of power system.

Question 3: how are the specific steps of classroom teaching designed to achieve the "round table classroom" teaching mode focusing on learning and combining teaching and learning, so as to make students become the masters of the classroom.

Solution: in the past, most teaching methods used cramming teaching, and students are prone to fatigue in the process of teachers' explanation. This course explores the teaching mode of "round table classroom" in view of the great reduction of students' interest and low efficiency of listening to classes caused by cramming teaching. The core of "round table classroom" is not a formal round table, but requires everyone to devote themselves to the classroom. Students

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are the center of the classroom and discussion is the basis of the classroom. The teacher will assign cases to the students before class. The students will study by consulting the materials to see what knowledge points need to be used. After preview, they will speak in turn in class and put forward their views. Other students and teachers will ask questions about his speech. Because the cases are all industrial application problems, the ingenious design can also improve students' learning enthusiasm and play an important role in the cultivation of active thinking and computational thinking.

Question 4: how is online teaching combined with traditional classroom so as to complement each other's advantages and achieve good results?

Solution: it is proposed to use mobile phones in the traditional class. In the past classroom teaching, there was no lack of students playing mobile phones. A highly operable supervision method can be adopted. Some small questions are set up in class to ask at any time, and students are required to send barrage answers in class. Although students' answers cannot be checked in class, barrage records can be checked after class so as to record their usual grades. In this way, students can hold their mobile phones in their hands, but they can no longer play entertainment. They must listen carefully to the lesson in order to interact timely and accurately when asking questions.

In addition, online teaching platforms such as Classroom Faction and Nailing have the function of recording and playback, which also makes up the defect of inconvenient review of classroom lectures. Whether online or offline teaching, using the live broadcast of teaching platform has become an effective means to ensure teaching quality.

4. Conclusion

In this paper, a curriculum knowledge system is build up with multi-disciplinary knowledge characteristics and problem-solving through the integration of case design and application fields. In addition, the knowledge system structure and teaching method innovation of intelligent optimization algorithms course are both designed to improve the teaching effect. Under the background of "Artificial Intelligence + X", all these work will be beneficial to cultivating interdisciplinary compound talents and modernization of the intelligent era.

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