Stratified and Diversified Teaching of Graduate Algorithm Course
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Keywords: Algorithm design and analysis, Postgraduate education, Curriculum construction,
 Educational reform.

Abstract. Based on the teaching practice of postgraduate courses, this paper discusses the
construction and teaching reform of the postgraduate algorithm of master degree in computer
 technology. A stratified and diversified teaching model is proposed that the extensible module
structure is adopted within the framework of unified algorithmic knowledge and the individualized
 teaching program is drawn up according to different learning bases and research directions as for
teaching content, teaching process, practice teaching, curriculum assessment and other aspects.

Introduction
Algorithm design and analysis can improve students’ computational thinking ability so that it is one
of the most important course of the computer professional curriculum system [1]. Through studying
this course, students will understand and master the main methods of algorithm design, master the
basic methods and techniques of algorithm complexity analysis, master the commonly used algorithm
strategy and application, understand some typical algorithm implementation, understand the latest
algorithm research movement, comprehensively understand the classical algorithm system and
modern optimization algorithm theory. The goal of the course is to focus on cultivating the basic
algorithm design capability, cultivating ability to analyze the time and space complexity of algorithm,
 improving ability to solve practical problems by using algorithm theory, laying a good foundation for
Algorithm analysis, design and optimization.

Content of the Course
The research of algorithms is one of the core problems of computer science that has great application
and theoretical value. The main content of the algorithm is to study computation and related problems
of non-numerical calculation of the commonly used method, therefore, it is one of the most important
professional courses of computer science and technology.

Knowledge Framework
The main content of the algorithm course system includes the classical algorithm and intelligent
optimization algorithm, the NP complete theory and probability algorithm, and the latest research
results and progress of the approximate algorithm. The knowledge framework of the algorithm course
is shown in Figure 1[2].

At the bottom of the knowledge framework of the algorithm is the basic knowledge of the
algorithm, including mathematical courses such as discrete mathematics, probability statistics and
computer courses such as data structure. These foreword curriculums will be given a brief
introduction according to students’ different learning foundation even if that have been set up at the
undergraduate level. The discrete mathematics course lays the foundation of logical thinking and
mathematical analysis for understanding algorithm analysis and design. The programming foundation
is the basis for students to complete implementation algorithm so as the data structure that the knowledge can be combined together in the teaching process.

In the knowledge framework of the algorithm, the core content is the design technology and analysis method of the algorithm. The classical algorithms play an important role in computer major study that involve divide and conquer strategy, dynamic programming, greedy algorithm, backtracking and branch and bound strategy. The algorithm analysis section focuses on algorithm complexity analysis, while the concept and theoretical framework of NP complete theory will be briefly introduced. The highest level of the knowledge framework of the algorithm is a combination of algorithmic research that includes the intelligent optimization algorithm, as well as the approximation algorithm, the parallel algorithm and the latest research hotspots and research trends.

**Key Content**

The course focuses on the algorithm design strategy, skills, commonly used methods and basic algorithm analysis methods, as well as the classic algorithm implementation case that will gradually develop students' thinking mode of designing and analyzing algorithms, and guide students to improve their ability of problem abstraction and modeling. Furthermore, the course will strengthen the students' understanding of the basic concepts and basic knowledge of analysis, algorithm design and algorithm complexity theory of computer algorithms that it is necessary to master the basic methods of algorithm analysis and algorithm design methods. Further deepen understanding of the algorithm design methods and comprehension will be completed through the analysis of the algorithm examples. Students are required to apply the method of curriculum to design algorithms commonly used in software development or complicated practical problems, as well as in the application of software development and testing capabilities through theoretical study and practice teaching.

Two key points are included in postgraduate algorithm teaching that is relative to the undergraduate teaching. One point is complexity and calculability theory, which is the expansion and improvement of undergraduate teaching contents, the other is modern optimization algorithm that is also called intelligent algorithm. The modern optimization algorithm is a heuristic algorithm developed in the early 1980s, including simulated annealing, genetic algorithm, neural network, tabu search, ant colony algorithm (1992), particle swarm algorithm (1995), and so on. These algorithms simulate the natural and human wisdom to achieve the optimal solution to the NP problem, so that it is called the computational intelligence optimization algorithm [3]. Some intelligent algorithms imitate the biological evolution process, some algorithms mimic biological physiology and physical function, or...
animal behavior, others imitate human thinking, language and memory process, or imitation of a natural physical phenomenon, to achieve the optimal solution on the problem. Intelligent algorithms have been greatly developed in theory and practical applications, so that they have been included in the key teaching contents of graduate algorithm courses.

Reference Materials

Based on the above algorithm curriculum knowledge framework and teaching content, the course is open to students of different research direction, soft and hard, multi-level and diversified curriculum learning structure. Therefore, the curriculum does not specify a fixed textbook while some reference materials will be recommended, such as Wang's *Computer Algorithm Design and Analysis* that deals with both classic and practical algorithms and case studies, hot spots, and tracking [4]. All of chapters of Thomas's *Introduction to Algorithms* are self-contained that can be used as independent learning units while the algorithm is described in English or pseudo-code that is easy to understand [5].

Teaching Process

During the teaching process it will be considered in two aspects of the design and analysis of algorithms that classical algorithm and modern content are complementary and should be combined theory with application. Algorithm strategy and algorithm analysis, as well as the content of modern algorithm theory are suited to classroom teaching, while algorithmic examples and application issues are fitted for teaching (accounting for a quarter of the proportion), student discussion (half of the school hours) and comprehension (accounting for a quarter of the proportion).

Capacity Training

As a professional basic course it take up the task of training the ability of students' computational thinking that is a universal scientific thinking method using computer science basic concepts and methods for describing, modeling and solving the problem [6]. We will make great efforts to permeate the thinking to the algorithm teaching to guide improve the ability of abstraction and modeling. It will be infiltrated in design strategy, techniques, commonly used methods and basic algorithm analysis methods, as well as the classic algorithm to achieve the goal of teaching process. We will pay attention to the connection between different algorithms through questions of extreme or special data in case of a certain strategy that may be beyond the textbook which can stimulate students' imagination and innovation ability. In addition, diversified teaching models are used according to the level of students, concern assigning different tasks, carrying out group discussion, selecting students' acceptable course examples and so on.

Practical Teaching

In the course of practical teaching, the experimental task is distinguishable for different levels of students because of undergraduate computer course basis or other reasons that experimental topics are provided with different options and requirements. The problems appearing in the experiment process are generally studied and solved by the students themselves that takes the student as the main body, while the teacher plays a role in inspiration and guide.

Research Activities

Extracurricular practice activities are carried out that provides an expanding space for students with research interests and exploration spirit combining scientific research with teaching. Those students who have a high degree of fitness for the activity are grouped according to their personal interests and expertise. The content, objectives and results of the activities are shown in Table 1.
**Curriculum Assessment**

Currently the theoretical assessment accounts for 70% of the course achievement while the curriculum practice assessment accounts for 20% and curriculum review or the latest research accounts for 10%. In order to stimulate students' innovation and system design ability, a more scientific assessment system will be established that the practical ability will be the key point of assessment. Practice links will be arranged in the extracurricular that is divided into individual operations and team operations at two levels. The individual work is the minimum requirement for practice examination that should be done independently in respect of algorithm design, program implementation and testing to cultivate the students' basic algorithm design and practice ability. The team work is focused on training students' algorithm design ability and team spirit by solving the comprehensive algorithm problems that consists of 2 to 4 persons with strong theoretical and practical ability.

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Activities</th>
<th>Target</th>
<th>Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Design</td>
<td>Optimize the classic and modern intelligent algorithm and encapsulate the program.</td>
<td>Improve algorithm optimization and design capability.</td>
<td>Algorithmic libraries and design documents</td>
</tr>
<tr>
<td>Algorithm Analysis</td>
<td>Analyze and improve the performance of the typical algorithm case.</td>
<td>Break through the framework of the existing algorithm and put forward different views to enhance innovate thinking ability.</td>
<td>Analysis report or program and test data</td>
</tr>
<tr>
<td>Project Team</td>
<td>Carry out engineering research projects.</td>
<td>Use theory to solve practical problems.</td>
<td>Project reports or procedures and test data</td>
</tr>
<tr>
<td>Theory Research</td>
<td>Study the latest algorithm research progress and application prospects.</td>
<td>Stimulate students' interest in research and cultivate their Computational Thinking spirit of innovation and exploration.</td>
<td>Summary reports or academic papers</td>
</tr>
</tbody>
</table>

**Summary**

The graduate algorithm teaching has been improved at a higher level based on the teaching experience of undergraduate teaching. In the process of teaching and practicing of postgraduates in computer science, we have carried on the preliminary exploration to cultivating computational thinking ability that is integrated into every link of teaching. A hierarchical and diversified method is put forward according to the characteristics of professional graduate students to improve teaching efficiency, to tap the potential of students, to cultivate students' ability to analyze and solve practical problems by utilizing computational thinking.

**Acknowledgement**

This research was financially supported by the Fundamental Research Funds for the Central Universities with project No. 328201504.
References


