



Research on Software Course Reform and Practice Across Different Architectures

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Abstract. LoongArch and Kunpeng architectures show good performances compared to X86 architectures. Considering the innovation in the information technology industry in China, we think deeply about the course reform of software engineering training and further explore the implementation results and existing problems of the course. To enable more students to learn knowledge of related architectures, we carry on reform and practice programs for course construction, by introducing LoongArch and Kunpeng architecture into the course of Java program development. This paper first introduces the teaching reform method, process, and achievement. Besides, the development process and performance of Java applications on different architectures are also discussed in this paper.

Keywords: LoongArch; Kunpeng; teaching reform; project practice.

1 Introduction

In recent years, with the development of the Chinese CPU, a representative of products met with success, such as LoongArch, and Kunpeng. The LoongArch is a MIPS architecture-compatible microprocessors developed by Loongson independently, which make LoongArch microprocessors not dependent on other foreign technology or authorization^[1]. The Kunpeng processor is an ARM-based processor, which aims to help developers accelerate application migration and computing capability upgrades^[2]. To keep pace with the latest technology in the information industry, we introduce LoongArch and Kunpeng architecture into software engineering training classes to improve the Java programming practice skills of students and learn different architectures knowledge. However, it is a pity that the traditional teaching method is not incommensurate with multi architectures for the new practical programming course, reasons are as follows. (1) As a widely used program language, Java is famous for higher cross-functionality and portability as programs written in one platform can run across desktops. While some teachers only told students this conclusion and ignored the theoretical reason and actual result. (2) Due to the lack of the actual environment of LoongArch and Kunpeng architectures, some teachers neither teach theoretical knowledge of different architectures nor provide opportunities for practice. (3) The traditional teaching

method focuses on whether the Java application running on the X86 architecture is successful. Therefore, it is essential to introduce the LoongArch and Kunpeng architectures into class and reform the teaching method to match with new technology. Thus, this paper firstly discusses the related work including the limitation of existing teaching methods and analysis of different architectures, further introduces the teaching reform of software engineering class, meantime studies the Java application running performance on different architectures, and also puts forward some thought of domestic architectures and related teaching reform.

2 Related Work

2.1 Limitation of Existing Teaching Method

The way of traditional teaching method aims to teach how to write Java applications and make them successful running on X86 architectures^[3]. There are some disadvantages of traditional teaching methods are gradually revealed such as content, approach, and training. Mastering Java language and masterly using different architectures is still a non-trivial task due to the following potential challenges.

(1) Lack of programming thinking cultivation. The main content of existing Java programming classes is Java basic grammar and some toy programs. These teaching content pay more attention to teaching Java language, which considers programming languages itself as important than thinking^[4]. It should be noted that the core of programming work is the logic of the program instead of language grammar, which is dependent on the programming thinking of the worker. The purpose of software engineering training is not language grammar knowledge reiterative training but is to train the student to master the basic theory, professional knowledge, and practical programming skills required for their major.

(2) Disconnected from the actual informational industry. The X86 architecture has always occupied a dominant position in the market, hence most programming classes select the knowledge of X86 architecture as primary content. On the other hand, other architecture technology is advancing rapidly, such as LoongArch and Kunpeng architectures are accepted by more and more information enterprises. It is important for university programming classes to update the related knowledge about the latest architectures to date. Therefore, to help students gain better job opportunities, introducing multi-architecture knowledge and improving practical skills is an inevitable choice to avoid disconnecting from the actual informational industry.

(3) Discrepancy of theoretical knowledge and practice skill. Students' coding practice skills are an important indicator in evaluating the teaching quality of software engineering majors^[5]. However, many students acquire knowledge of domestic architecture only through books, and because of the lack of LoongArch and Kunpeng architecture hardware environments, improving students' practice skills was even more difficult than with the X86 platform. Lack of coding practice training on real projects causes students to usually feel quite helpless in the face of practical problems.

2.2 Analysis of Different Architectures

As domestic scientific and technological strength increases, domestic advanced architectures show strong momentum due to high-speed development. This paper introduces LoongArch and Kunpeng, which are widely used in the information industry. LoongArch covers both desktop and server fields. Kunpeng covers desktop, server, and embedded OS. Kunpeng uses a huge number of registers, and most data operations are performed in registers, and instructions are executed faster^[6]. Currently, many Java applications are running at X86 architectures, and there is an urgent need for designing Java applications on LoongArch and Kunpeng to expand the application ecosystem and achieve broad development.

In brief, the existing teaching content and method are not settled in the pace of technological development, especially for LoongArch and Kunpeng architectures. Taking the course software engineering training as an example, this paper introduces some reforms and practices in the teaching process. Besides, the compared performances of some Java applications among LoongArch, Kunpeng, and X86 architectures are discussed in this paper.

3 Teaching Reform and Practice

3.1 Teaching Reform

The "software engineering training" is a course that combines programming language grammar theory and practical programming technology^[7]. The course aims to cultivate practice skills in programming techniques and strives to establish a program logic thinking system for students. In this teaching reform, we proposed the new teaching mechanism of the theory content, practical part, and real project as assignments to evaluate students' study results. Figure 1 draws the whole framework of the teaching reform mechanism of the "software engineering training" course. Teaching content involves Java grammar, Java programming practice, and LoongArch and Kunpeng architecture. Some new teaching methods are also introduced into class to enhance teaching efficiency, such as group discussions, and PAD teaching^{[8][9]}. We separate class time into three processes, Presentation, Assimilation, and Discussion, which gives more time for students' self-arranged learning and individualized internalization.

In this teaching reform, it is vital to introduce LoongArch and Kunpeng architecture and improve Java programming skills in real projects. More importantly, while striving to make students improve Java programming skills, it also focuses on cultivating students' belief in rigorous academic attitude, awareness of patriotism, sense of social responsibility, capacity for independent thinking, "insight" analysis and reasoning ability, etc., realize the organic combination of knowledge transfer and value guidance^[10].

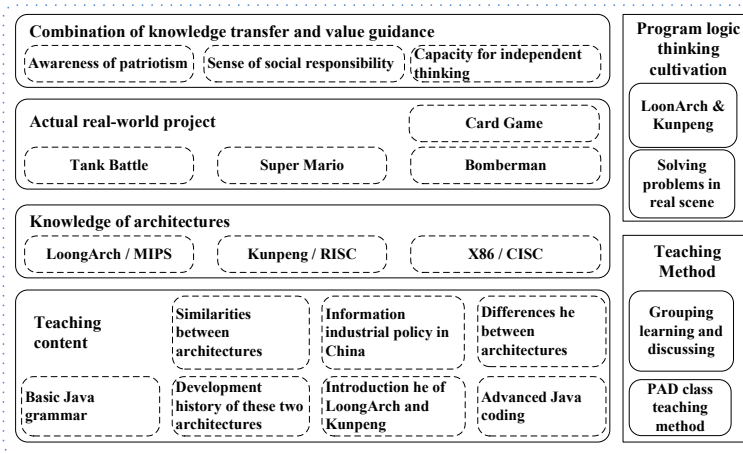


Fig. 1. The teaching mechanism reform of "Software engineering training" course

3.2 Teaching Content

The purpose of the “software engineering training” course is to strengthen the training of Java programming ability, which fills a gap between theoretical grammar knowledge and practical coding scene. However, teaching content falls behind the real application, especially the appearance of LoongArch and Kunpeng. To upgrade the last knowledge, we introduce theoretical knowledge of different architecture into teaching content. The main contents are as follows: the introduction of LoongArch and Kunpeng, the information industrial policy in China, the development history of these two architectures, the CISC instruction set, the LongISA2.0 and MIPS instruction set, the RISC instruction set, the knowledge between heavy-core and multi-core, and light-core and many-core, the similarities and differences between LoongArch Kunpeng and X86, the usage scenario of LoongArch and Kunpeng, Java environment configuration on LoongArch and Kunpeng, Java application compiling process in these two architectures, and instance program on LoongArch and Kunpeng.

3.3 Teaching Practice

Thanks to the collaboration with Loongson and Huawei, Loongson and Huawei company respectively provide a virtual environment including LoongArch and Kun-peng architectures for demonstrating instance Java programs and code Java applications. To evaluate teaching reform results and students’ study results, we require students to finish a real project a Java application, which is an interactive online battle game. The requirements of the interactive online battle game are as follows. (1) Involving basic Java grammar, the graphical user interface, and the TCP/IP or UDP client and server network programming technology. (2) Java application successfully running on LoongArch, Kunpeng, and X86 architectures. (3) The other new techniques, such as database, game top-up function, and so on.

Through teaching reform including content and practice, the final exam score shows excellent rates of more than 25%. Also, more than 90% of students give praise to the teaching planning based on new teaching mechanisms. The improvement of course grades and students' feedback indicates students have not only mastered the Java programming ability on different architectures but also are trained to cultivate programming thinking by solving practice problems and improving practice skills.

4 Analysis of Java Applications on Different Architectures

4.1 Analysis of Performance

In this section, we analyze the performance of the same Java application on LoongArch, Kunpeng, and X86 architectures. By using the performance testing tools JMeter on different architectures, we select an accumulation calculator Java application and set the number of simultaneous users to 100 for testing the response time and the number of successfully executed users. Table 1 shows the test result.

Table 1. The calculator Java application test result

| | LoongArch | Kunpeng | X86 |
|--|-----------|---------|-------|
| Response time (s) | 21.43 | 21.41 | 21.32 |
| The number of successfully executed user (%) | 95 | 94 | 97 |

The conclusions of studying the result table are that LoongArch and Kunpeng have almost the same performance on the calculator Java application. Some differences may cause network or parametric configuration.

4.2 Case Study of Java Application on Different Architectures

This course explores teaching reform and practices via a set of comprehensive theoretical knowledge, a real practice project of Java application on different architectures, to effectively teach the course "Software engineering training". During the course, students finish the Java application independently, and more than 93% of students successfully run the game on three architectures. Some creative games leave a deep impression on teachers, such as Super Mario, Tank Battle, Card, Bomberman, etc. This case study indicates the advantage of Java of platform-independent still surviving on different architectures, which is important to widely promote the LoongArch and Kunpeng architecture for the information industry.

5 Conclusion

This paper reviews some limitations of the existing teaching mechanisms of Java programming courses and analyzes different architectures. Then we discuss a new attempt at teaching reform and practice on LoongArch, Kunpeng, and X86. Furthermore, we

analyze the performance of Java applications across different architectures. The focus of the course reform and practice is to master different architecture knowledge, improve practical skills, cultivate programming thinking, and learn to solve real problems, which can meet the latest industrial circle requirements. Based on the reality of teaching reform, the new teaching mechanism gained results to some extent.

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