A Snapshot of Undergraduate Computing Education in China

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Abstract

Computer science (CS) and information technology (IT) are playing an increasingly important role in Chinese economy and society. They also have great impact on many aspects of the world. Computer science undergraduate education is an essential element in bringing out workforce or research personnel to meet the demand in such a society. In this paper we examine undergraduate CS curricula from a collection of eight elite Chinese universities, hoping to give an inside look at the system that generate large number of graduates every year. Our study reveals some interesting facts, as compared to typical undergraduate computer science programs in the U.S. These selected Chinese undergraduate computer science programs largely are similar to most U.S. programs, requiring some standard computer science courses such as introduction to computer science, data structures, computer organizations, operating systems, and algorithm analysis. On the other hand, they require more computer science courses and more engineering courses. They require more application-oriented CS courses such as database, compiler, and computer networks. Students typically take more courses and credit hours per semester.

1. Introduction

China's undergraduate computing education, started in the late 1950s, has gone through tremendous changes in recent decades, both in numbers and in contents, in response to the changing needs of the economy, research, and social development. By 1960, about 15 universities in China offered computing related programs[2] [1]. According to [2], there are 2,603 computing related programs with 901,000 students in these programs in 2015, making up for about 16 percent of the entire engineering student body in China. The graduates coming out of the pipelines are playing increasingly more important role in science, engineering, and economics of the country in general. The graduates are also becoming very competitive at various international stages, including areas in academics and economics. To help us better understand undergraduate computing education in China we examine in this paper the undergraduate computing curriculum in a few selected programs. The topics covered include computer science core requirement, math and science requirement, other common requirement including social sciences, humanity, and arts, credit hours required to graduate, among some other subjects. The rest of the paper is organized as follows. Section 2 reviews related work in

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2 We use "computing related programs" to refer all relevant programs such as computer science, computer engineering, computer science and engineering, computing technology, information technology and such, though the study in the paper focuses on "computer science."

the area of computing education in China. Section 3 gives an overview of computing education in China including some historic notes. Section 4 discusses the methods used and the type of data collected in the study. Each of the Section 5 and Section 6 presents the data and a summary of the computer science course requirement, as well as math, science, and engineering course requirement in the programs under study, respectively. Section 7 discusses the requirement for social sciences, humanity, and arts. We explore and present some special characteristics of computer science education in China in Section 8, discuss the limitation of the study in Section 9, followed by some concluding remarks in Section 10.

2. Related work

Though the computer science education in China started in the late 1950s [3], it is relatively recent to see any English publication on the study of Chinese computer science education. Li and Lunt in 2006 [1] discussed a brief history of computer science education in China, indicating that the Ministry of Education in China (MEOC) started a systematic review of the status of computer science education in China around 2005, aiming to improve the computer science education. Zhang and Lo [4] reviewed status of the CS education in China around 2010. The paper reported some important statistics such as the number of departments or colleges offering computing degrees, the pyramid model of computing education, i.e., technology-oriented, engineering-oriented, and science-oriented. The paper also listed major course requirement for the computer science degrees. Huang and Hang [5] presented the result of their study to improve the "entrepreneurial spirits" of Chinese computing undergraduates, as the country moves towards applying computer science and information technology in many aspects of everyday life. Jiang [6] studied and compared three computer science programs each in China and in the U.S. The selected schools from the U.S. represent national research universities, public regional universities, and small private liberal arts universities. A similar group of schools was selected on the Chinese side; with the key difference that a typical third-tier technology-focused Chinese university is very different from the liberal arts colleges in the U.S. The paper by Douglas *et al.* [7] reported an initiative to explore internationalization of computer science education. The authors established a Pacific Rim community of computer science departments and high tech firms to explore a new model of computer science education focusing on the knowledge, skills, and competencies necessary for professional success and leadership in a global context. Our study differs from the above-cited work in that we examine the curricula in detail of the eight elite Chinese computing programs. We also collect and study requirements in math, sciences, and engineering, as well as social science, humanity, and arts of these programs.

3. Computing education in China

Higher education in China has been experiencing a rapid growth in recent decades. According to the latest statistics from MOEC [8], as of 2017 there were 2,631 institutes of higher education with almost 38 million students. While the MOEC report does not divide the students into different majors, the report by the Working Group for Software Engineering Curriculum [2] indicates about 901,000 students were in 2,603 computing related programs as of 2015. If we divide the number of students into four class years, roughly 225,000 graduate each year. (Almost 100 percent of Chinese students graduate on time, a different subject to study.) As a quick

comparison, according to National Center for Education Statistics [9], the number of BS CS degrees awarded by the U.S. institutes of higher education was 35,329 in 2016, or about 15 percent of the number of Chinese graduates.

In China, the name and the size of the degree programs are regulated by MOEC in public colleges. The independent colleges largely follow the same pattern. Computing related majors comprise over 100 different majors, of which 40 are offered at the bachelors degree level, the rest are associate or other degree types [2]. The prominent majors include Computer Science and Technology, Software Engineering, Network Engineering, Information Security, Internet of Things, and Digital Media Technology. The computer science and technology major is considered as a general education degree, while other degrees are considered as applied majors with which graduates are expected to go to industry right after school.

According to [3], Chinese computing education can be divided into three major development periods. The first period started in 1956, following a 12-year plan by the State Council of China at the time. The 12-year plan identified computer as one of the six emerging areas of importance. A couple schools, including Tsinghua University and Harbin Institute of Technology, started the computing majors in 1956. By the end of 1950s, more than 10 colleges initiated computing majors. The focus at the time was on designing and building computers, or computing devices. A few sample courses of the time include Principles of Electric Engineering, Digital Circuits, and Programming Design (in machine language). Because of the interruption to higher education in the Culture Revolution (1966-1976), the colleges admitted groups of students in three-year programs starting early 1970s. Sample courses in this period include Principles of Transistors, Small Computers Based on Microprocessor, Computing Storage, Assembly Programming, BASIC Programming, Fortran Programming, RTOS Operating Systems, etc. The second major development period of computing education started in 1977. The National Science and Technology Commission of China again listed computing as one of the eight key areas. The highlight of this period is that the country invited international experts, especially the American computer scientists, to give lectures to Chinese professors. While early computing education in China was embedded in departments such as electrical and electronic engineering, or industry automation engineering, a number of colleges founded their first computer science and engineering department in the early 1980s. The courses offered saw a major shift from circuits, hardware, assembly programming to a balanced collection of theory, software, and hardware. Sample courses include Engineering Mathematics, Linear Algebra, Discrete Math, Computer Architecture, Pascal Programming, Data Structures, Operating Systems, and other modern electives. The third major development period came in 1995, as the internet became a driving force in all aspects of people's life. In 1994, MOEC adjusted the content and the name of the major, making computer science and technology the name of the major across the nation. By 2003, 505 colleges had computer science and technology major. The courses now follow well-established models of having hardware as the foundation, software as the emphasis, computer networks and database courses as the core. The curriculum also started to include management, economics, and humanity elements. A number of elite colleges established college or school of computing. The MOEC initiated 37 "national exemplary" colleges of software engineering in a group of leading universities around 2001. In comparison to computer science, software

engineering majors reduced or removed the courses in hardware, especially in electronics, and added modern software engineering courses such as software system design, management, development, and testing.

More recently, MOEC and the computer science education community in Chinese higher education started a new initiative named "New Engineering Education" in which computing related education sees a new era of development. In 2015, the ACM China Committee on Education published the translated Chinese version of *ACM Computer Science Curriculum 2013* [10], an indication that the Chinese computer science education community starts to pay close attention to the commonly accepted standard in the U.S. Also started in 2015, finished by 2016, MOEC and a working group created a set of guidelines for undergraduate curriculum of applied computing majors such as software engineering, network engineering, and internet of things. An example is the guidelines for software engineering [2]. An overwhelming strategy is to divide computing majors into more specific application areas such as AI, computer security, software engineering, among others. A number of universities founded schools or colleges in these specialties. For example, according to [11], over 70 Chinese universities and colleges have introduced AI-related majors. There are 38 AI colleges as of February 2019 [12].

The computer science graduates play an increasingly important role in Chinese economy and social development. Here are some examples. In the ten semi-annual listings of the 500 fastest super-computer competition in the last five years, the Chinese super-computers placed 16 spots in the top 100 spots [13]. The Chinese-made super-computers claimed first in nine of the 10 listings [13]. Two of the top 10 most valued public listed companies of the world in second quarter of 2018 are Chinese tech companies, Tencent and Alibaba [14]. Chinese online e-commerce giant Alibaba Group surpassed the value of the U.S. online retailer Amazon in 2017 [15]. Chinese cell phone company Huawei surpassed Apple as the world's second largest smart phone brand (first is Samsung) in 2017 [16]. Student teams from China won a total of eight top medals (two gold, five silver, one bronze) in the International Collegiate Programming Contest (ICPC) in the last three years (2016, 2017, and 2018) [17], [18].

4. Methods of study and the type of data collected

Given the increasingly important role that computer science and technology plays in economics and social development, it is of great interest to examine how Chinese universities educate their undergraduate students. As [2] indicated, there are about 901,000 students in 2,603 computing related programs in China as of 2015. It is very difficult, if not impossible, to conduct a comprehensive study in all these programs. However, because the Chinese higher education is highly regulated by MOEC, all schools follow the guidelines of MOEC to set up their curriculum. (See for example, [19].) Without loss much of generality, we study the computer science curricula of a selected group of eight elite Chinese universities, Tsinghua University (*Tsinghua*), Shanghai Jiao Tong University (*SJTU*), Southeast University (*SEU*), Peking University (*PKU*), Beijing University of Post and Telecommunications (*BUPT*), Harbin Institute of Technology (*HIT*), University of Science and Technology of China (*USTC*), and Beihang University (*BUAA*). (See Appendix A for the list.) We chose these programs based on the recent *U.S. News* listing. The computer science programs in these universities are among the best in

China. In addition, their curricula are readily available on the internet, either in Chinese or in English. We left out a few excellent Chinese CS programs from the *U.S. News* list because we cannot easily locate their curricula online.

The data collected include the required computer science courses, the required math, science, and engineering courses, the required social science, humanity, and art courses, as well as the hours for each of these courses and the total semester hours required for graduation. One of the challenges in comparing semester hours of study is that every school may use a different mechanism to define their credit hours and to count the semester hours. We took the face value of what each school declares. Another challenge is that the length of the semester is not all the same across different schools, nor are they the same across the academic year (spring semester vs. fall semester). We again take a simplistic approach here, just assuming all semesters have 16 weeks of lecturing time when converting weekly hours to semester hours.

5. Computer science course requirement

We first examine the computer science course requirement in these Chinese universities. Here "computer science course requirement" include the core required courses and the elective courses of which students typically are required to take certain number. While it is difficult to discuss the exact content of the courses, we infer the course content by the titles assigned by these universities. We compare the total credit hours required to graduate, the number of courses, credit hours, and the number of hours for all computer science courses, including required number of hours for electives. The total number of hours is computed as weekly hours times the number of weeks, if the total number of hours is not specified by the school. Some schools designate some commonly recognized math courses as computer science courses, i.e., giving them computer science course numbers. We took the liberty to move such courses to the math course category. Examples include discrete math, probability and statistics, and modern algebra. In addition, some schools list the lab or project portion of the course separately from the course, while others do not. The hours listed in the table below follow whatever the schools listed. It could be slightly misleading in some cases, depending on whether or not the lab or project portion of the courses is listed separately. Table 1 shows the four pieces of data from the eight schools. The credit hours as well as the total hours are the summation of all computer science courses for a particular school.

Table 1: Count, credit hours, total hours for computer science courses, total credits to graduate

	Tsinghua	**SJTU**	**SEU**	**PKU**	**BUPT**	**HIT**	**USTC**	**BUAA**
CS course count	18	13	14	18	20	22	27	15
CS credits	51	48	46	53	54	84.5	85	58
Total CS hours	816	756	728	880	864	1312	1508	1716
Degree credits	172	165	150	150	153	167.5	162.5	140

The required CS courses vary between 13 (SJTU) to 27 (USTC). Five schools require 13-18 CS courses, three require over 20 courses! The course count, thus the credit hours, includes required core courses and the required number of electives.

We now take a look at the course titles, from which we could infer the contents, offered by each school. The course titles vary a great deal among different schools. Some common courses can be identified, even though the titles for these courses may not be the same. We choose some commonly recognized titles for these core courses for easy comparison. See Table 2 for the listing and comparison. The values listed in the table are the semester hours which are obtained from the websites of the respective schools. We note that each school may assign the semester hours differently. In addition, some schools include the lab/project hours in the overall hours, others list separate project or lab hours. As such, the semester hours listed in the table are for reference only. Tsinghua University and Peking University do not assign semester hours, but only credits to the courses. In these two cases, we multiply the credits by 16 (for 16 weeks) to get comparable semester hour values. Abbreviations of the course titles are used in Table 2 for better presentation. See Table 3 for the mapping between the abbreviation and the course titles.

Table 2: Common CS courses across the eight schools (semester hours)

	Tsinghua	**SJTU**	**SEU**	**PKU**	**BUPT**	**HIT**	**USTC**	**BUAA**
CS1	48	48	72	48	64	32	40	32
CS2	64	68	64	48	64	56	60	48
Org	64		64	48	64		100	112
OS	48	80	64	64	64		60	114
SE	48		48		48	80	40	
CP	32		64	48	48	48	60	98
AL		48		64	32	48	60	32
AR	48	80			48		60	
DB			48		48	48	60	
Net	48		48		64	48	60	
TH	32				32	32	60	
Other	384	442	256	560	256	840	848	1280*
Total	**816**	**766**	**728**	**880**	**832**	**1232**	**1508**	**1716**

*The 1280 credit hours in "Others" category of BUAA include a senior design of 12 credits, 960 hours.

Table 3: Mapping between abbreviations and course titles

Abbreviation	**Title**
CS1	Introduction to computer science
CS2	Data structures
Org	Computer organization
OS	Operating systems
SE	Software engineering
CP	Compiler
AL	Algorithms
AR	Computer architecture
DB	Database
Net	Computer networks
TH	Theory of computation

Note that in the list of courses in Table 2, we use some of the well-known course titles. The "Others" category include all other computer science courses, required or electives, listed by the respective schools. The titles could have missed some information in specific courses and curricula. For example, SJTU does not have a course in computer organization, but it does have a course in computer architecture. HIT does not have a course in computer organization, nor operating systems, but it does have a course called "Computer Systems" which may cover many of the topics in these two courses. The "Computer Systems" course is listed in the table in the "Others" category. With some caveat, overall the course titles used in Tables 2 capture the general contents of the courses in discussion.

Also, note that USTC and BUAA have a substantial more number of total CS course hours than the rest of the schools. It seems that USTC indeed require a heavier course load for their students. For example, USTC students often take more than 10 courses and 25 plus credits per semester. In the case of BUAA, its senior design is listed as 12 credits, which is not surprising. However, its 960 semester hours are unusually high for the equivalent course credits. If we count its senior design as 12 credits with 12x16 (weeks) = 192 hours, the total CS course hours for BUAA would be 948, which would be about what other schools have.

It is worth noting that six of the eight schools require an algorithm course; seven of the eight schools require a compiler course; five of the eight schools require a software engineering course. The other two points of interest is that database and computer networks courses are required in four and five of the eight schools, while they would be electives in most U.S. schools. Such is also the case for the compiler course. This reflects an emphasis on the engineering or application nature of the curriculum.

6. Math, sciences, and engineering course requirements

We follow a similar pattern to examine the math, sciences, and engineering course requirement for the computer science programs in these eight schools. We first look at the math requirement. Table 4 lists math hours, as well as course count, credits, and total math hours required of the eight computer science programs.

Table 4: Math requirement (semester hours)

	Tsinghua	**SJTU**	**SEU**	**PKU**	**BUPT**	**HIT**	**USTC**	**BUAA**
Calculus I	80	96	64	80	80	88	120	96
Calculus II	80	68	64	80	80	88	120	96
Probability and statistics	48	51	48	48	64	56	60	48
Linear algebra	96	48		64	48	64	80	96
Discrete math	96	32	80		80			96
Others	80	51	80	144	32	168	266	
Course count	**9**	**6**	**7**	**7**	**7**	**8**	**11**	**6**
Math credits	**30**	**21**	**23.5**	**26**	**24**	**29**	**35**	**24**
Total hours	**480**	**346**	**336**	**416**	**384**	**464**	**646**	**432**

The Calculus I and Calculus II in Chinese universities typically mean single variable calculus and multi-variable calculus, respectively. This is different from many U.S. universities in which the topic of multi-variable calculus usually is treated in a Calculus III course. This is why no Chinese schools, at least in the eight schools under our study, has a Calculus III course. Besides the calculus courses, we can see from Table 4 that all schools require a probability and statistics course. Seven of the eight schools have a linear algebra course. SEU, though does not have a linear algebra course, has a course called "Geometry and algebra." The three schools that do not have a discrete math courses cover the content in other courses. PKU has three separate courses, "Sets and graphs," "Algebra and combinatorics" and "Mathematical logic." HIT has "Sets and graphs" and "Mathematical logic." USTC has "Graphs." Of the five schools that have "Discrete math" in their math requirement, all but SJTU have a two-course sequence, "Discrete math I" and "Discrete math II."

The math requirement across the eight schools runs from six and 11 courses, 21 to 35 credits, and 336 to 646 credit hours.

Now let us examine the science and engineering course requirement for the computer science degrees in these schools. In general, science requirements usually contain physics only in these schools. Again, this is different from most of the U.S. universities, which typically require other science courses such as chemistry or biology. Besides science requirement, all these programs require certain amount of engineering courses, mostly in the area of electrical engineering, including digital logic.

Table 5: Science and engineering requirement (semester hours)

	Tsinghua	**SJTU**	**SEU**	**PKU**	**BUPT**	**HIT**	**USTC**	**BUAA**
Physics I	80	68	64	48	64	72	140	92
Physics II	80	68	64	48			140	
Analog circuits				80	32			
Digital logic	64			48	64	56		
Analog and digital circuits		80	96				120	
Others	128	64	144	48	40		390	

As can be seen, the science and engineering course requirements vary much more across schools, compared to the requirement of computer science courses and math courses. All schools except BUAA require a digital logic (or analog and digital circuits) course. It is possible that BUAA has the digital logic component in other courses. Overall, these schools require physics course(s) as the science requirement. No schools require other areas of sciences such as chemistry, biology, or any other natural science courses.

7. Social sciences, humanity, and arts requirement

In this section, we examine the non-technical courses required by the eight Chinese computer science programs. Chinese universities, similar to the U.S. universities, have a general education requirement that are common across majors. Usually these requirements do not include courses

such as calculus or physics, which are considered as technical courses. These non-technical general education courses can be divided into two categories. One set of courses appear in almost all schools. For example, all our eight sample universities have a PE (Physical education) requirement and an English requirement. Seven of the eight schools require such courses as Principles of Marxism, Contemporary Chinese History, Fundamentals of Moral Ethics and Laws, and Military Theory. The second set of non-technical general education courses are other social sciences, humanity, and art courses that students can choose from a given collection of courses. Table 6 below is a summary of these two categories of non-technical general education courses.

Table 6: Summary of course credits of non-technical general education courses

	Tsinghua	**SJTU**	**SEU**	**PKU**	**BUPT**	**HIT**	**USTC**	**BUAA**
Fundamentals of moral ethics and laws	3	3	3	2	3	2	3	
Mao Zedong thoughts and the theory of socialism with Chinese characteristics	4	6	3	4	4	4		
Contemporary Chinese history	3	2	2	2	2	2	2	
Basic principles of Marxism	4	3	3	2	3	3	3	
Military theory		1	1	2	1.5	3	1	2
Physical education	4	4	4	4	4	4	3	4
Current affairs and policies			0.5	1	2	1	1	2
Foreign languages	16	15	9*	8	8	4	12	
Others	13	12	12.5	12	6.5	13	43	22**
Total gen. ed. credits	**47**	**46**	**38**	**37**	**34**	**36**	**68**	**30**
Percent of total credits* **	**27%**	**27%**	**25%**	**25%**	**22%**	**21%**	**42%**	**22%**

Note: * SEU requires English 2, 3, and 4. English 1 is not listed.

** BUAA requires a sequence of four “Ideology and politics” courses, Basics, Outlines, Overviews, and Principles for a total of 10 credits.

*** Percentage of the total credits is computed as (gen. ed. credits) / (total credits). See Table 1 for the number of total credits required by the degree programs from each school.

We can see from the table that a number of common courses are required across different universities. The “Others” category contains much of the requirement similar to what the U.S. universities would call social sciences, humanity, and arts. Some universities put specific requirement in this category. Tsinghua requires a reading/writing course. The 12 other credits required in SJTU must come from humanity, social science, and natural science blocks, one course or two credits from each. SEU requires courses from environmental, sustainability, economics, finance, literature, law, social science, and arts. Example courses from other universities include mental health, safety, professionalism, life sciences, and technology development.

8. Some notes in undergraduate CS education in China

A few things are worth noting that would help us understand Chinese higher education in general, and computer science education in particular.

Semesters in Chinese universities

Chinese universities usually use a two-semesters-per-year calendar system. The fall semester usually goes from mid-September through mid- or late January before the Chinese New Year. The spring semester starts after the Chinese New Year and ends sometime in early-July. The key is that the two semesters do not necessarily have the same lengths. The lengths of the semesters of the eight schools vary from 17 weeks to 20 weeks including exams. Summer semesters run from four weeks to 10 weeks, though not all schools require students take classes in the summer.

Courses in a semester and student load

Some schools offer courses that are shorter than a semester. For example, one course could run for weeks 1 through 8, another course could run from week 9 through week 16. The degrees in China typically requires more total credit hours, as well as more computer science credit hours to graduate, compared to typical U.S. institutes. For example, Tsinghua University and USTC requires a total of 172 credit hours and 162.5 credits to graduate, respectively. Students often take more credit hours and courses per semester than most U.S. universities. For example, a sample curriculum shows that USTC computer science students take 11 courses worth 27.5 credits in their first semester in college. Note that course count alone does not necessarily reflect the actual workload of a student. Other factors such as the amount of programming, course related research, writing and presenting papers and other course-related activities all play important role in student workload.

Emphasis on applications

It is interesting to note that the curricula of these eight programs include more application components in their required computer science courses such as database, compiler, and computer networks. This is more than a typical U.S. program would have as required courses. We think this is partially because of the fact that MOEC guidelines contain these specific course titles [19]. It is an indication that the Chinese programs emphasizes more on applications.

More engineering components

The computer science programs, at least in the universities under our study overall require more engineering (mostly electrical engineering) courses. For example, of the eight schools, with the exception of BUAA (0 hours) and HIT (1 course, 56 hours), the engineering course hours range from 3 courses, 136 hours in BUPT to 5 courses, 250 hours in USTC.

Social sciences and humanity courses

Chinese universities require certain amount of social sciences and humanity courses in their computer science curricula. Some elements of these requirements are similar to those in the U.S. universities such as history, psychology, management, among others. Some other elements are unique to the Chinese systems such as the study of Marxism or contemporary Chinese history.

9. Challenges, limitations, and future work

Challenges and future work remain in such a study. For example, how to take into account the fact that the Chinese programs require more hours and more courses for their degree programs? What are the reasons behind the fact that these Chinese programs require more courses and credit hours? What are the meanings of "credit hours" exactly in different universities? Would it be possible to conduct a statistical analysis? How can we make meaningful comparison in student workload? How can we as computer science educators make use of the data found in this study?

Another limitation of our study is that we use course title to infer the course contents. While this approach gives an overall picture of the curriculum in various programs, the course contents do vary by the school, even if the course titles are similar or identical. It will need a focused study to investigate the contents of individual courses.

We view our current study purely as informational. We hope the study can bring us discussions about Chinese computer science education. We hope in the future we would be able identify the pros and cons of the Chinese curricula, as compared to the commonly adopted U.S. curricula. We hope the two systems, the one in China and the one in the U.S., can learn from each other, as next generations of computer science students will play important roles in their societies.

10. Conclusions

In this paper, we examine the undergraduate computer science curricula in a few selected Chinese universities. The selection is based on the recent *U.S. News* ranking. The schools under study include Tsinghua University, Shanghai Jiao Tong University, Southeast University, Peking University, Beijing University of Post and Telecommunication, Harbin Institute of Technology, University of Science and Technology, and Beihang University. We chose these universities because they are among of the best computer science programs in China and their data are readily available over the internet, either in Chinese or in English.

We compared the total number of courses and semester hours of four sets of courses across the eight universities, computer science, math and sciences, engineering, and general education that include social science, humanity, and arts. We found that these schools require more total courses and hours, in particular in computer science and mathematics, compared to typical U.S. programs. The degree programs in these Chinese universities require more credit hours to graduate.

We hope the study shed some lights on Chinese undergraduate computer science education as computer science and IT play increasingly important role in the Chinese economy, just as they do in the U.S. It is important for all to understand how future computer scientists and engineers are educated in China.

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Appendix A: List of programs under study

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