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Experience and Enlightenment of Computer Science Discipline Construction in Indian Institutes of Technology

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Abstract
Indian Institutes of Technology is believed to be the world famous engineering university and its fame comes mainly from its prestigious academic discipline of computer science conducted in the department of computer science and engineering. High quality faculties, outstanding scientific research, closed linkage with industry and talents development are the experience that China needs to refer in the educational strategies of world first-rate disciplines construction.

Key words: Construction of world-class discipline, Computer science discipline; Indian Institutes of Technology

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INTRODUCTION
Indian Institutes of Technology, known as IITs is regarded as India's even the world excellent institutions for teaching and research in engineering and technology. In 1947, to India's great fortune, Jawaharlal Nehru took charge as the country's first Prime Minister. With the purpose of accelerating India's development through education and research in scientific and technology disciplines and rendering India stand out with extraordinary success and achieve global reach and stature, the great leader of India made his visionary venture to set up a group of institutions called the Indian Institutes of Technology. From Kharagpur in 1950 to Jammu in 2016, there are now potentially world-class twenty three engineering institutions in the family, among them five older IITs of IIT Bombay, IIT Delhi, IIT Kanpur, IIT Kharagpur, IIT Madras are established preliminarily to cater to the nations need for quality technical manpower. It is believed widely that IITs have to excel not only in engineering education but also in research, innovation and extension activities among the world's best research universities. The core elements of the IIT vision expressed in Nehru's words, the Sarkar Committee, 1961 Nayudamma Committee reports and 2004 reports are as follows:

• The basic function of IITs is production of scientists and engineers of the highest caliber through education. It should be tightly integrated with research and extension.

• Goals & tasks of the institutes should relate continuously to changes taking place in the socio-economic development of the country and ...rapidly exploding universe of knowledge in science and technology.

• IITs should embody the student with values, enthusiasm and ability to engage in research, design and development to help building the nation towards self-reliance in her technological needs. (IIT Review Committee, 2004, p.33)

IITs characterize itself apart from the rest of the hundreds of engineering colleges:

• Nearly all of IIT faculty members have Ph. D. Their research interests impact their teaching, govern their consultancy methods and enable their continuing education.

• The faculty members at IITs enjoy full academic autonomy and are able to update their curricular to keep pace with the modern developments.

• The continuous assessment of students, with particular emphasis on tutorials, leads to continuous learning.

• Students evaluation of teaching is an established norm among the IITs.

• Much academic activity occurs in their libraries, around their laboratories and computing facilities, which are made available to students till late hours in the evening.

• Students have the opportunity to interact with post-graduate and Ph.D. research scholars. (IIT Review Committee, 2004, p.5)

1. ACADEMIC DISCIPLINE OF COMPUTER SCIENCE IN INDIAN INSTITUTES OF TECHNOLOGY

Computer education conducted at the computer research centers at the preliminary phase of the establishment of Indian Institutes of Technology can be considered as the beginning of the creation of computer science discipline in IITs. Since the establishment of computer science department in the 1970s and the computer science and engineering department in the 1980s, the computer science discipline of Indian Institutes of technology has entered its historical process of creation, development and prosperity essentially. Endowment of large amount of first-rate faculties in computer science, the Indian Institutes of Technology has trained a large number of top-level and advanced computer scientists. The pioneering scientific studies for India and the world has made IITs become model of computer science in Asia even the world. It also serves as a platform for India to become an information technology Great Powers. Indian Institute of Technology Delhi, Indian Institute of Technology Bombay, Indian Institute of Technology Kanpur and Indian Institute of Technology Madras are ranked ahead in the UK QS World University Discipline Rankings.

2. EXPERIENCE OF COMPUTER SCIENCE DISCIPLINE CONSTRUCTION IN INDIAN INSTITUTES OF TECHNOLOGY

One of the crucial reasons for those world-class universities standing out of the ordinary others is their first-class disciplines attached to those prestigious universities. The academic reputation of Indian Institute of Technology is inextricably linked to the world-class level of computer science discipline. High quality faculties, outstanding scientific research, closed linkage with industry and its talents development contribute together to the world fame of compute science discipline of IITs.

2.1 High Quality Faculties

IIT Bhubaneswar director Prof Madhusudan Chakraborty described what makes the IITs special: these are teacher-based institutes, meaning that the brand is built by its outstanding faculty. (Out of the shadows and into the sun, 2011, p.19)

Over the years, the IITs have been able to attract large amount of outstanding bright faculty members who have made great contribution to building and maintaining the IITs brand discipline of computer science not only in India but also worldwide. The key function of the IIT faculty is to be engaged in advanced research and deliver advanced teaching course concerning discipline of computer science. Almost all of the faculties of computer science discipline have a doctorate degree acquired from first rate world-class universities, which facilitates for the outstanding talents to undertake important national and international collaborative projects. Several eminent professors are illustrated in the following as examples.

Dr. Phalguni Gupta received his Doctoral degree from Indian Institute of Technology Kharagpur in 1986 and joined the Department of Computer Science and Engineering, Indian Institute of Technology Kanpur in 1987. He has produced a large amount of research fruits with about 300 published papers in International Journals and International Conferences, 2 books and 14 book chapters. He has conducted several sponsored and consultancy projects funded by the Government, some of which is focused in the research filed of Grid Computing, Image Processing, Mobile Computing, and Network Flow. He has established the Biometrics Lab at IIT Kanpur.

Krishna M. Sivalingam is the head of the Department of Computer Science and Engineering, Indian Institute of Technology, Madras. His research interests include wireless networks, wireless sensor networks, optical wavelength division multiplexed networks, and performance evaluation. He holds three patents in wireless networks and has published several research articles including more than fifty journal publications. He has published an edited book on Next Generation Network Technologies in 2011, on Wireless Sensor Networks in 2004 and optical WDM networks in 2000 and 2004. He serves on the Steering Committee of IEEE International Conference on Advanced Networks and Telecommunications Systems and ICST International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services He is a Fellow of the IEEE, Fellow of INAE and an ACM Distinguished Scientist.

2.2 Outstanding Scientific Research

The tangible results of research at Indian Institutes of Technology are typically in the form of Ph. D. theses, research publications, books, knowledge-intensive products, government sponsored research, research grants resulting from the MoUs (alliances) with other institutions, conference organized and so on. (IIT Review Committee, 2004, p.83)

National and international MOUs have yielded sponsored research projects in some cases. A strategy

for the MOU, in particular with eminent universities abroad, has to be thought through. It should be possible for each IIT to build closed links with one or two leading universities overseas. It should also be possible to build into such alliances Ph. D. Programme for students in the two partnering institutions, as is being attempted by the Department of Science and Technology in the Indo-German programme of collaboration in nanoscience and technology. (IIT Review Committee, 2004, p.69)

IIT's will also benefit from inter-IIT alliances. Such alliances can be cast between departments and/or between disciplines among a pair or more of the IITs. Once a mechanism is in place for meaningful interfacing between departments /disciplines, cooperative endeavors in research as well as for improvements in curricula can be attempted. Many sponsored projects are implemented with the inter-IIT alliances, for example, Computer Graphic & Multimedia project sponsored by IIT Kharagpur, Computational Number Theory & Cryptography sponsored by IIT Chennai.

National and international conferences, workshops, seminars and symposia dominate the landscape of IITs. This suggests that IITs may be playing a critical role in facilitating knowledge dissemination within and out of the country. During the year of 2009-2010, conferences, workshops and symposia attended by academic scholars of computer science national and international account for only 7, while four years later, during the year of 2014-2015, academic scholars in IIT Guwahati has attended national and international conference concerning academic disciplines of computer science with papers published amounts to 54. It is just one example to show that exchange and communication of academic teaching and research would facilitate the development and advancement of computer science to some extents.

Various research centers concerning computer science are installed in Indian Institutes of technology. It also plays a crucial role in facilitating the research and development of computer science academic discipline to a more advanced level. Center for Computational Brain Research of Indian Institute Technology Madras explores the interface between Neuroscience and Engineering disciplines. A two-way interaction is envisaged, where an understanding of the brain can help drive significant technological advances, and in turn engineering tools can help analyze and probe neural circuits. Within this overall vision, CCBR will pursue two broad areas of activity: analysis of the structure and activity of neural circuits as well as brain-inspired hardware and software architectures.

Initiative and creative scientific research are always bore in mind and entailed by the prestigious scholars and students of Indian Institutes of technology. A 170-member team of professors and students at IIT Jodhpur has developed the world's cheapest Tablet—Aakash after 18 months of study and research. (Out of the shadows and into the sun, 2011, P.3)It is an Android-Based tablet computer promoted by the Government of India as part of an initiative to link 25,000 colleges and 400 universities in an e-learning program and was officially launched in New Delhi on 5 October 2011. The debut of Aakash on the world stage is attributed to the combined effort of IITs, Indian and western world, cause it is developed by IIT academic and research group, produced by the British-Canadian company Datawind and manufactured by the India-based company Quad, which is a strong and evident proof of the closed collocation of IITs with organizations domestically and abroad.

2.3 Closed Linkage With Industry

It is not overestimated that the prestigious statures of IITs Computer Science academic discipline derive from its interaction with the industry. IITs were created by the Government of India for the benefit of the society, an important part of which is the industrial sector. Actually it is a win-win strategy. Talented students who do research and development projects for certain sectors of the industry become the prospective and would-be absorbed graduates after graduation by the companies on one hand, the amount of outstanding and talented graduates would also make great contributions to the sections in the near future on the other. Obviously some of them have risen to and promoted to high positions and played an important role in the domains.

IITs have made a distinct model which reflects its great endeavor in making connected linkage with industry. It is an internal cell within the system, called incubator cell/center and started in 1972 in IITM. The cell operates as a window for various services that the IITs can offer as well as serve as a techno-commercial interface. With a professional outlook, the cells have taken a more active role for marketing and business development. Furthermore, IT explosion has also contributed to an impressive growth in this segment of industry interface. Many small and medium enterprises take good advantages of it to acquire valuable shoe-string budgets in short time durations which are of great preciousness for them to develop and expand further, especially for those in the start-up stage. Projects with large outlays an involving setting up of dedicated research centers have also been in place as in the case of VLSI Design Centre in IITKGP, Software Validation and Verification Centre in IIT Bombay. In addition to that, the IBM, TATA Infotech and NIIT research centers at IITD illustrate the potential and the possibilities high level research base creation.

2.4 Talents Development

2.4.1 Prestigious Jee

Indian Institutes of Technology is famous also for the Joint Entrance Examination, abbreviated as JEE which is

conducted jointly by the Indian Institutes of Technology and believed to be the most prestigious competitive science examination in the country. It has become the flagship of the IITs for the standards of probity and confidentiality in the conduct of the examination. JEE has enjoyed a reputation of transparency and rigor of the selection process and is also to pick the most outstanding and talented students from a very large potential pool. The average enrollment rate is only in the neighborhood of 3%, even lower than Stanford University with the average rate of 5.05%. JEE is widely believed to be one of the strictest and most difficult entrance examinations in the world. Mathematics, physics and chemistry are the main tested subjects. Those who get the total required scores can not be enrolled directly because there is also a minimum score line for each of the subjects. In addition to the written examination, candidates are required also to participate in up to five days of interviews, during which they can choose their majors according to the order of their written examination scores.

2.4.2 Various Degree Programs

The discipline of computer science of IITs is developed through the department of computer science and engineering which is established in most of IITs system. The mission of the Department of Computer Science and Engineering is to provide high quality postgraduate education and undergraduate education and undertake cutting-edge research in computer science. Academic programs implemented by the Department include: Bachelor of Engineering, five-year Bachelor of Science and Technology and Master of Science and Technology, Master of Engineering, dual degree master of engineering, Master of Science and Ph.D. Teaching and research laboratories equipped with advanced computing facilities provide a platform for teaching and research activities in the discipline.(Zhejiang University, 2008: P.393) Computer science discipline in Indian Institute of Technology generally entails the majors of computer science and engineering, computer technology, computer applications and other professionals with a variety of curriculums including core courses, elective courses and institute-wide optional classes. There are training courses on "independent research" in the training programs of two engineering masters in computer technology and computer application, which shows that the discipline emphasizes on cultivating the independent research ability of students. The superiority of training and practice hours reflects the characteristics that computer science places on developing student engineering practices and hands-on skills. This is closely related to the discipline characteristics of computer science. Although it has similarities with the traditional basic disciplines of mathematics, physics and chemistry, they differentiate from each other. The former not only bears the features as the traditional basic subjects but also contains the characteristics of engineering. Therefore, the combined nature of both science and engineering requires the combination of science and engineering in computer science and technology. Computer disciplines should not only cultivate the development of theoretical research and basic system of personnel, but also develop practical talents who have advantages in application system development.

2.4.3 First-Rate Graduates

There is no doubt that the Indian Institute of Technology is at the forefront of developing countries in the construction of first-class disciplines because it has become a "world famous university" by cultivating a large number of world-renowned IT elites. IT education implemented in Indian Institute of Technology is second to none in the world, and its information technology professionals are trained all over the world. Silicon Valley in the United States is the place where these IT professionals gather together to take initiatives. According to statistics, there are 250,000 people engaged in the software industry in India, of whom 80,000 directly serve customers in Europe and the United States, most of these 80,000 graduates are from the Indian Institute of Technology. The most influential people and leaders in the field are the Indian Institute of Technology graduates. For example, one of the founders of Sun Microsystems, also acts as the first CEO and Chairman, Vinod Khosla graduated from Indian Institute of Technology Delhi; Amit Singhal, Honorary Engineer of Google, a world famous search engine company, gets a Bachelor's degree in Computer Science from the Indian Institute of Technology Roorkee; Chief Executive Officer, President and Managing Director of Infosys, India's Information Technology Industry, Nandan Nilekani was a former student in Indian Institute of Technology Bombay and chairman; chief adviser of Infosys , N.R. Narayana Murthy ever pursued his study as a postgraduate in the Indian Institute of Technology Kanpur; Deputy Managing Director and Chief Operating Officer, S. S. Gopalakrishnan holds a master's degree in computer science from the Indian Institute of Technology Madras. Pichai Sundararajan, an Indian-American computer engineer with a bachelor's degree in engineering and being awarded a silver medal from the Indian Institute of Technology Kanpur, is the Chief Executive Office and Chairman of Google in 2015. It is strongly proved that Indian Institutes of Technology is an outstanding institution with its first rate computer science discipline worldwide for it is a place in which such a large number of graduates of information technology among the world's knowledge and technology sector are nurtured here and a crucial role it has played in the world of informational economic technology.

3.ENLIGHTENMENT OF COMPUTER SCIENCE DISCIPLINE CONSTRUCTION IN IITS TO CHINA

3.1 Inspiration to China's World First-Class Construction

As early as 1998, China proposed the goal of building a world-class university. In August 2015, the leading group for deepening the reform of the Central Government reviewed and adopted the Overall Plan for Co-promotion of World-class Universities and First-class Disciplines to further clarify the guidelines and specific goals of the country in building a world-class university. It clearly puts forward that the construction of world-class universities should be conducted with the construction of first-class disciplines. In this way, the horn of building world-class universities and first-rate disciplines under the new historical conditions has been sounded.(Zhou, 2016, P. 65) As an important content of the reform and development of higher education, building a first-class discipline should actively refer advantageous experience from the history of successful discipline construction in other countries and make some contributions to our country.

In the era of knowledge economy, the information technology industry is one of the most promising sunrise industries and has a positive impact on the country's economic development and social progress. Large amount of excellent IT personnel graduated from and trained by Indian Institutes of Technology has played an important role in promoting the rapid development of India's information technology industry, especially the software industry. Indian Institute of Technology's world-renowned training of cutting-edge IT professionals is closely related to the rapid development of computer science discipline. It is believed that the nurturing process of IITs' Computer talents experiences from the preliminary stage of creation, development to the advanced stage of expansion is in consistent with the development process of computer science discipline. It is beneficial to investigate the development history of Indian Institute of Technology's computer science, explore its characteristics in the academic team, teaching and research platform construction, scientific research and personnel training mode and their interrelationships, summarize the Indian Institute of Technology computer science construction experience with the purpose of exploring the path of world-class discipline growth and the building of first-class disciplines, which will be of great significance to China. At the same time, compared with developed countries in Europe and the United States, India which has a similar background to China as far as their national conditions and historical development are concerned, is most valuable for China to refer in the process of establishing a first-class discipline in higher education. Furthermore, it is vitally important for China to conduct information technology education successfully and promote China's economic growth ultimately.

3.2 Grasping the Law of First-Rate Discipline Construction in Theory

The history of the construction and development of computer science in Indian Institute of Technology reflects some of the basic elements of successful construction of disciplines. Analysis of these basic elements and exploration of their interrelationship and impact on the discipline construction would be helpful for the China's education policy makers and subject builders who can get some enlightenment and reference to grasping the direction of our country's first-class disciplines and speeding up China First-class discipline construction process. This article would be meaningful in attempts to clarify the relationship between the elements of discipline construction, summarize the general rules and characteristics of the discipline construction and development, and finally get some experience and enlightenment.

3.3 Practical Significance of Chinese Information Personnel Nurturing

Building world-class universities and first-rate disciplines is an important direction for the reform and development of China's higher education. It is of great significance for enhancing the overall level of education in our country and enhancing our core competitiveness. In August 2015, the leading group for deepening the overall reform of the Central Government reviewed and adopted the Overall Plan for Promoting World-Class Universities and First-Class Discipline Development, and proposed that a batch of high-level universities and disciplines should be promoted to the first-class rank in the world or the forefront. China and India have relatively similar national conditions and historical development backgrounds. Compared with the world-class universities and first-class disciplines among developed countries in Europe and the United States, the creation, development and flourishing of Indian Institute of Technology's computer science discipline provide precious and valuable experience for China to construct First-class disciplines, implement successful information technology education and promote China's economic development. At the same time, the Indian Institutes of Technology computer science discipline has trained a large number of outstanding and world-leading IT talents, they constitute the world's elite information technology community and act as the main power in information technology field worldwide. As early as 1985, the Indian government started to support the computer software industry in order to make full use of the advantages of scientific and technological personnel. At this time, China's electronic software industry has just started. By 1998, India's total output value of the software industry has reached 3 billion U.S. dollars, while that of software industry in China was about 1.5 billion U.S. dollars in 1999. The development gap between China and

India can not be ignored. Today, China's information technology industry is still in its infancy, especially the software industry. Obviously it can not be compared with India. Admittedly, the combination of many factors restricts the development of the information technology industry in our country. However, the total shortage of software talents and the lack of high-end IT personnel are the important reasons for the relatively lagging development of China's information technology industry. Computer science discipline of IITs owns first-rate teaching and research faculties, implements various and flexible degree program, conducts high-level scientific research and development projects especially a large amount of industry-linage research programs, which would be of great benefit for China to explore a more practical reference in building eminent disciplines of world famous university and highlighting the significance of the study of this topic.

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