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Comparison of Undergraduate Curriculum Systems of Artificial Intelligence Programs in China and the United States—Taking Tsinghua University and Massachusetts Institute of Technology as Examples

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Abstract: Currently, artificial intelligence has been developing rapidly. It has become the new engine for economic development, the core driving force that triggers a new round of rapid industrial transformation and the strategic technology that leads the future. Countries around the world have been actively promoting the development of AI education to cultivate top talents in the field of AI. This article makes a comparative study of the the undergraduate curriculum system of AI majors in Chinese and American universities, taking Tsinghua University and the Massachusetts Institute of Technology as examples. And then it summarizes effective experiences, to provide suggestions and improvement strategies for the construction of undergraduate AI curriculum system.

1. Background

Currently, artificial intelligence (abbreviated as AI in the following) is developing rapidly and has become a strategic technology leading scientific and technological revolution, industrial transformation and social change, which has significant impact on economic development, social progress, and international political and economic patterns. Hence, countries around the world have been strengthening their strategic layout of AI, actively promoting the development of AI education to cultivate top talents in the field of AI. According to the “2023 Global Artificial Intelligence Innovation Index Report”, the global development of AI maintains the overall pattern of the United States being in the lead overall and the US and China leading together. Therefore, we can get important enlightenment by studying AI education in both countries.

Massachusetts Institute of Technology (MIT) is one of the world’s top research universities, its development in the field of AI has always been at the forefront of the world. Tsinghua University (THU) is one of the “Double First Class” universities that China has been focusing on constructing, serving as a base for cultivating high-level talents and conducting scientific and technological research. Accordingly, the undergraduate AI curriculum system and talent training mode of the two universities are representative. This article takes the curriculum systems of the Bachelor of Science in Artificial Intelligence and Decision Making at MIT and AI class of the Bachelor of Computer Science and Technology at THU as objects of study. This article aims to compare the characteristics of the undergraduate curriculum systems of AI in two universities then obtain some effective

enlightenment.

2. Comparison of the undergraduate curriculum system of AI majors in two Universities

The curriculum system is the bridge for universities to implement educational concepts and achieve talent cultivation goals. It determines the knowledge and abilities that students can possess. This study focuses on what kind of talents need to be cultivated and how to cultivate talents in the undergraduate programs of AI. Therefore, it studies on training objectives, curriculum structure, curriculum content and course implementation.

1) Comparison of curriculum objectives

The cultivation objective of the AI Class at THU includes the following three points: first, students have a comprehensive mastery of the basic theories and cutting-edge application knowledge of AI, to have strong ability in scientific research practice and to be capable of lifelong learning. Second, students possess good scientific literacy and innovative spirit, and become international top-notch innovative talents that capable of engaging in AI research. Third, students have professional ethics and a sense of social responsibility, and have the same or even higher competitiveness as undergraduate students of the world's top universities.[1]

The training objectives of the Artificial Intelligence and Decision Making program at MIT can be broadly summarized as follows: to provide students with the strong mathematical and algorithmic foundations needed to build robust systems that can extrapolate from data to insights and decisions. Students will learn the skills needed to understand data, model real-world phenomena, and build the future in which technology truly benefits humanity.[2] Then graduates should be at the forefront of a great many of these advances in their professional fields, and leading innovation and leadership in education and research.

By comparing the curriculum objectives of two universities, it can be seen that their objectives are similar. Both are committed to cultivating leading talents in the field of AI who are proficient in the professional foundation, possess good scientific literacy, innovative spirit, and strong practical ability. Both focus on cultivating talents who can apply knowledge and skills of AI to solve complex real-world problems. And both hope that their students can maintain a leading position in teaching, research, and innovative applications in the field of AI.

2) Comparison of curriculum structure and content

The curriculum of the AI Class at THU includes two categories: university-level general education courses and professional courses. General education courses include ideological and political theory, physical education, foreign languages, writing, military theory, and general electives, totaling 46 credits. In the category of professional course, there are basic courses including compulsory mathematics and physics courses, totaling 29 credits; core courses of the major, totaling 49 credits; practical training and thesis, totaling 20 credits.

The curriculum for the Bachelor of Science in Artificial Intelligence and Decision Making at MIT consists of foundation course module, which includes 5.5 subjects in basic math and computer science courses; core course module, which has a breadth requirement of 5 subjects from 5 areas; electives course module, in which students should choose 2 subjects drawn from applications or other advanced material, 1 subject from Social and Ethical Responsibilities of Computing subjects list; and other parts which includes 1 additional communications-intensive subject.

The professional courses of the two universities are shown in the following table.

Table 1: Professional Course of Undergraduate AI Programs of Two Universities

Professional Course	AI class of the Bachelor of Computer Science and Technology, THU	Bachelor of Science in Artificial Intelligence and Decision Making, MIT
Basic Course	Mathematics Compulsory: Calculus A 1, Calculus A 2, Linear Algebra, Abstract Algebra, Probability and Statistics Compulsory Physics: General Physics 1, General Physics 2	subjects in basic mathematics and computer science: Introduction to Computer Science Programming in Python, Introduction to Algorithms, Fundamentals of Programming, Mathematics for Computer Science, Linear Algebra and Optimization, et al.
Core Course	Introduction to Artificial Intelligence, Applied Mathematics for Artificial Intelligence, Algorithm Design, Computational Theory, Artificial Intelligence: Principles and Technologies, Machine Learning, Deep Learning, Computer Vision, Data Mining, Natural Language Processing, Artificial Intelligence Crossover Project (AI+X), Artificial Intelligence Research Practice	Data-centric: Introduction to Statistical Data Analysis , Introduction to Machine Learning Model-centric: Signal Processing; Computer Graphics; Inference, and Reasoning in AI, et al. Decision-centric: Dynamical System Modeling and Control Design ; Representation, Inference, and Reasoning in AI; Optimization Methods Computation-centric: Computability and Complexity Theory; Design and Analysis of Algorithms, et al. Human-centric: AI, Decision Making, and Society; Interactive Data Visualization and Society, et al.
Elective Course		AI+D Advanced Undergraduate Subjects: Statistics, Computation and Applications; Robotic Manipulation; Large-scale Symbolic Systems; Advances in Computer Vision; et al. Social and Ethical Responsibilities of Computing Subjects: Modeling with Machine Learning: from Algorithms to Applications, Foundations of Information Policy, et al.
Others	Summer semester courses: Information Physics, Algebra and Computation, Introduction to Database Systems, et al.	Communication-intensive in the Major: Robotic Manipulation, Advances in Computer Vision, Quantitative Methods for Natural Language Processing, et al.

Comparing the curriculum structure and content of two universities, it can be found that both of them have modular and systematic characteristics. The knowledge that students should master is divided into several module to help students learn professional knowledge of AI from shallow to deep, from narrow to broad. The curricula of both are based on theoretical knowledge such as mathematics and computer fundamentals, centered on the core knowledge and skill of AI, extended by a rich selection of elective courses, general education courses, and practical courses, forming a curriculum structure with a clear composition of knowledge and ability, and a clear distinction

between primary and secondary. By comparing the curriculum structures and the course offerings of two universities that shown in the table 1，it can be found that they have some differences. Firstly, THU has a higher proportion of general education courses, and require a greater amount of content to be learned, while MIT does not have any mandatory general education courses, except for physical education courses. Secondly, the proportion of elective courses at MIT is much higher whether in terms of AI professional elective or general elective courses. Especially in terms of professional elective courses, THU students have a relatively smaller range of choices. Thirdly, MIT places greater emphasis on the ethics and social morality courses related to AI. It provides a list of Social and Ethical Responsibilities of Computing Subjects for students to choose from. THU does not specially offer humanities or ethics courses closely related to AI.

3) Comparison of course implementation

For AI class at THU, [all of the core courses are taught entirely in English, aiming to create an international teaching mode and cultivate an international mindset for students. Besides, international experts and scholars in the field of AI will also be invited to give lectures and seminars to broaden students' international visions.[3] In addition, students are encouraged to apply for visiting research at top international institutions which fully funded by the institute. Students also have joint internship opportunities with the AI industry to gain a deeper understanding of cutting-edge basic scientific issues in the actual industries. It is also worth mentioning that the AI class adopts a broad-based and cross disciplinary training model. Senior students will adopt cross-disciplinary joint AI+X course project, to have the opportunity to combine AI with the academic frontier of other disciplines, participate in deep cross-cutting collaboration among different disciplines.

At MIT, students move toward mastery of areas of individual interest, through coursework and significant research, often defined in interdisciplinary areas that take advantage of the tremendous range of faculty expertise in the department and, more broadly, across MIT. In addition to classroom teaching, students can also learn through laboratory subjects, independent projects and research for principles and techniques of analysis, design, and experimentation in a variety of fields. There are also a range of programs that enable students to gain experience in industrial settings, ranging from collaborative industrial projects done on campus to term-long experiences at partner companies.[4]

It can be seen that both universities have diverse approaches on program implementation. Both attach great importance to interdisciplinary training methods, so the teaching staff and practical projects are cross-disciplinary. Besides, both of them focus on cultivating students' practical abilities. The implementation of courses is not limited to the classroom, but provides students with much opportunity to exercise in the practical projects and cooperative enterprises. Slightly different, THU places greater emphasis on cultivating students' international thinking and visions

3. Suggestions for the construction of undergraduate curriculum system of AI

First of all, when setting the objectives of the programs, the demand of the country and the society for AI talents should be fully considered. It should be oriented to solving issues of important theoretical and practical applications in the field of AI, and reflect the attention to the leading knowledge, skills and innovative research ability of students. Universities should cultivate talents with solid theoretical foundation and application ability of AI, who can apply AI-related knowledge and skills to solve important and complex real-world problems.

Secondly, in the setting of the curriculum structure, professional courses can be divided into different modules to make the curriculum structure more systematic. Universities should emphasize the cultivation of core knowledge literacy of AI major, set up professional courses scientifically, to make students able to build a systematic knowledge framework. Then, Elective courses that are

connected or extended to core courses should be set up as widely as possible, based on the focus on the depth and breadth of theoretical knowledge, as well as the cultivation of comprehensive and interdisciplinary thinking.

Thirdly, in the selection of courses, besides basic theoretical knowledge, it should also closely monitor the latest research progress and academic achievements in the field of AI, and strengthen the teaching of cutting-edge AI theories and technologies. Then, it should focus on the teaching of cross-disciplinary knowledge, deepen the cross-fertilization between AI and other disciplines such as medicine, finance, etc., continuously enrich and improve the interdisciplinary knowledge system, and cultivate AI talents with cross-disciplinary background. Moreover, it should set up courses that combine AI with humanities, society, ethics and law, to enhance students' legal awareness and ethical standards, and stimulate their thinking on the ethical and social value of AI.

Finally, the implementation of courses should be diverse, and not be limited to classroom teaching. In addition to providing students with professional and interdisciplinary classroom teaching, students should also be given ample opportunities to delve into projects and practices related to AI specialties to combine theory with practice and solve problems in practical situations. Universities should also strengthen the tripartite cooperation with the government and enterprise, to provide students with opportunities to participate in industry projects or practical projects, and provide students with opportunities and platforms to use AI technology to solve industry application problems.

References

[1] Undergraduate training program of Computer Science and Technology (Artificial Intelligence Class), Tsinghua University:https://www.tsinghua.edu.cn/jxjywj/bksjywj/28-3-jisuanji.pdf

[2] Instoduction of Artificial Intelligence and Decision making: https://www.eecs.mit.edu/ research/ artificial-intelligence-decision-making

[3] Tsinghua University Cross information research institute intelligent class enrollment announcement: https://iiis.tsinghua.edu.cn/show-8840-1.html

[4] MIT Artificial Intelligence and Decision Making (Course 6-4):http://catalog.mit.edu/ degree-charts/artifical-intelligence -decision-making-course-6-4