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Education Improvement Plan Related to Data Analysis & Processing in the ICT Field for the Era of Hyperconnectivity & Superintelligence

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Abstract

Since the 4th Industrial Revolution is implemented based on superintelligence, new insights must be provided through convergence studies with other fields to find optimal solutions to create new ideas. In this paper, we intende to present improvement measures for probability and statistical education, which is an athlete's subject on data analysis and processing in the ICT(Information & Communication Technologies) field in the era of superintelligence of the 4th industrial revolution. This paper aims to strengthen competitiveness through early development and commercialization of new technologies by presenting probabilities and statistical curriculums that require linkage in the ICT field. Second, it is necessary to present an educational system diagram linking probabilities and statistics in the ICT field to prepare a mid- to long-term response strategy for ICT education in response to innovative changes. Third, through a survey, we intend to present an effective educational operation plan linking probability and statistics to ICT major subjects by analyzing the perception of probability, statistical importance, and utilization of majors in this field.

Keywords: *Artificial Intelligence, Bigdata, Curriculum, Electronic Engineering, Probability, Statistics, Software*

1. INTRODUCTION

The 4th Industrial Revolution is a next-generation industrial revolution in which intelligent information technologies such as Artificial Intelligence, the Internet of Things, Bigdata, and mobile are fused to existing industries and services or combined with new technologies in various fields. With the convergence of digital devices, humans, and physical environments, the speed and impact of change are rapidly evolving, and academic boundaries such as digital, biology, and physics are disappearing and spreading to the field of convergence is emerging [1]. The characteristics of the quaternary industry can be summarized as hyperconnectivity, hyperintelligence, and predictability. Superconnectivity in which humans and humans, objects and objects are connected to the Internet communication network, superintelligence in analyzing large-scale data to identify certain patterns, and predictability in predicting human behavior based on the analysis results [2]. In particular, hyperconnectivity refers to the extinction and database of reality-virtual boundaries due to full-scale digitalization online. As a result, the collected data is made of Bigdata, and it is the basis for superintelligence by deriving valuable information in real time through large-capacity data utilization and

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analysis, trend analysis, and quick decision-making. Superintelligence can be said to be the development of Artificial Intelligence through data analysis and machine learning [3, 4]. As a result, the expansion of hyperconnectivity and superintelligence results in the convergence of various areas that have been previously separated. IT is characterized by convergence to create new technologies, industries, media and services based on the convergence of technical elements between hardware and software due to the disappearance of real-virtual boundaries between technologies, industries, and media [5]. Among the ICT field subjects, software and electronic engineering majors that use data analysis and processing as essential tools must have an organic relationship and be dealt with in depth in connection with probability and statistics subjects. However, it is considered difficult not only to improve academic achievement but also to achieve efficient educational effects related to convergence by systematically teaching-learning probability and statistical subjects related to data analysis and processing through traditional education methods.

2. THE ROLE OF PROBABILITY AND STATISTICS IN THE ICT FIELD

ICT is a comprehensive meaning of not only computers and communication technologies but also all technologies necessary for informatization, and the goal is to establish an information society using automation, computerization, and system. In this paper, the ICT field is limited to software and electronic engineering.

2.1 Probability and Statistics Curriculum in the Field of ICT

Table 1. Educational goals in the ICT field related to probability and statistics

Curriculum	The goal of education.
Major liberal arts course	- Introducing the overall basic concepts of probability and statistics - Introducing tools to organize or analyze ICT fields and natural phenomena - Acquiring how to design indicators and diagrams to efficiently manage information from vast amounts of data
Basic major course	- Acquiring mathematical problem solving in the ICT field as a probabilistic approach - Acquiring with statistical accessibility when making decisions based on realistic data generated in the ICT field - Cultivating the ability to recognize, analyze, and solve problems in the ICT field
Intensive and applied major courses	- Cultivating the ability to learn each major track specialty field based on various topics introduced in the ICT field - Cultivating the ability to link probabilities and statistics to use technologies, methods, and tools in the ICT field - Introducing cases of using Bigdata in smart technology
Major practice and new technology application process	- Educating to cultivate new technology applicability and practical skills by converging probability and statistics in the ICT field - Educating the learner to design a stochastic model on his own, in order to actively challenge the development of new technologies in the future - Teaching how to acquire problems arising after element and process design, experimental plan, and performance through statistical solutions

Probability and statistics are operated as player subjects related to data analysis and processing in the ICT curriculum. The ICT curriculum consists of a major liberal arts course, a basic major course, an in-depth and application course, and a major practice and new technology application course. However, probability and statistics courses that have traditionally been taught and learned in the same way for decades are not suitable for the era of intelligent informatization of the Fourth Industrial Revolution. The probability and statistics courses of the ICT curriculum suitable for the current time are required, and the detailed educational goals are shown in Table 1.

2.2 Probability and Statistical Contents that Require Linkage in the ICT Field

The software curriculum is divided into five tracks: System Integration Track, Software Development Track, Embedded System Software Track, Multimedia and Game Software Track, and Business Information Track. Five tracks of the electronic engineering curriculum: microwave and light wave tracks, semiconductor and electronic material tracks, system and control tracks, information communication and signal process tracks, computers and circuit tracks, and computer and circuit tracks. Tracks requiring linkage are business information technology tracks, multimedia and game software tracks in the software field, and information and signal processing tracks, systems and control tracks in the electronics field. In particular, regression analysis/multivariate statistical analysis/nonparametric methodology/probability process theory can be linked to multimedia and game software tracks in the software field and information communication and signal processing tracks in the electronic engineering field, respectively. Probability theory can be linked to information communication and signal processing tracks in the field of electronic engineering. Multivariate statistical analysis/statistical data processing/statistical data mining can be linked to business information technology tracks in the software field. Probability and estimation/nonparametric methodology can be linked to systems and control tracks in the field of electronic engineering.

3. AN EDUCATIONAL SYSTEM LINKING PROBABILITIES AND STATISTICS IN THE ICT FIELD

First of all, ICT education should be aimed at strengthening technical capabilities in the rapidly changing ICT field and developing advanced technologies by educating basic knowledge and scientific thinking of probability and statistics needed in software and electronics. Second, in order to continuously pursue a leading position in the ICT field, probability and statistics expertise must lead to national competitiveness by securing original technology and technological innovation through academic exchanges in the software and electronic engineering fields. Third, probability and statistics should present systematic and differentiated ICT education plans by providing the ability to understand and analyze data, to plan and conduct experiments, to recognize engineering problems, to formalize and solve engineering problems, and to use technologies, methods, and tools necessary for engineering practice. Figure 1 shows the education system diagram related to probability and statistics in the ICT field.

4. IMPROVEMENT OF EDUCATION RELATED TO DATA ANALYSIS AND PROCESSING

4.1 Research Methods and Results

In this section, software and electronic engineering majors analyze probability and statistics by grade in data analysis and processing major subjects, especially fourth graders, to reveal that electronic engineering majors are more aware of probability and statistics than software majors. For this study, C departments in software and E departments in electronic engineering at S University Science and Technology University located in Seoul were selected, and 40 students from each grade voluntarily participated in the study, and a survey was conducted from June 17 to 28, 2019.

ICT education goals	- Fostering experts in the field of software to implement a hyperconnected intelligent society in the future, based on computing thinking and logical problem-solving capabilities - Training professional technical personnel who can efficiently design, develop, and operate a computer system that combines hardware and software components, in the field of electronic engineering, through understanding and utilization of computers
▼ ▼	
Curriculum linking probability and statistics	- Developing learners' competencies through the opening of linked courses to foster talent with creativity and control skills - Establishing a customized education system that can maximize learning effects through convergence education using intelligent information technology
▼ ▼	
Effectiveness of education in terms of students	- Providing systematic practical education through the realization of problem-solving and thinking skills-oriented education, not memorization and injection-type education - Promoting a complete reorganization of teaching methods, academic systems, and curriculum to support learners' autonomous competency development and future preparation
Effectiveness of education in terms of industry	- Securing the best technology capabilities by actively conducting basic science and source research, which is the basis of the intelligent information industry, centered on universities - Developing and advancing the technologies that are closely linked to data noise removal and purification technologies, uncertainty removal, and noise processing
▼ ▼	
Expanding educational infrastructure and establishing a network	- Establishing educational infrastructure to strengthen educational capabilities through the operation of innovative convergence curriculum - Establishing a convergence-based curriculum system as a network and efficiently distribute it to domestic universities for application
▼ ▼	
Performance maximization between disciplines	- Training core talents related to intelligent information technology through interdisciplinary linkage and integration between ICT and probability and statistics - Promoting innovation in future education through convergence talent education by utilizing basic science and technology in the field of software and electronic engineering
▼ ▼	
Improving national competitiveness	- Training industrial manpower through new industry start-ups and start-ups in the field of intelligent information technology, in order to develop the ICT industry and create opportunities - Contributing to securing technology early in high value-added industries and strengthening overseas competitiveness in the field of software and electronic engineering in Korea

Figure 1. The education system diagram related to probability and statistics in the ICT field

Table 2 shows the analysis of the results of the questionnaire on the probability and statistical importance awareness of software and electronic engineering majors by grade. According to Table 2, software and electronic engineering majors gradually recognized the importance of grades and statistics as they went up to higher grades, and it was found that probability and statistics courses were opened in the second grade curriculum. In particular, it was found that electronic engineering majors perceived the importance of probability somewhat high. The reason was found to be that probability was used as an essential tool in relation to noise processing in the electronic engineering curriculum.

Table 3 shows the analysis of the results of the questionnaire on the probability of each track and statistical importance of software and electronic engineering majors. According to Table 3, probability is found to be somewhat more important in the multimedia and game software track of software, the system and control track of electronics, and the information communication and signal tracks. Statistics were found to be somewhat highly aware of the importance of software in the Business Information Technology Track and the Information Communication and Signal Process Track of electronics.

Table 2. Analysis of the probability and statistical significance perception by grade

Type	Grade	Major	N	Result (%)
Recognizing the importance of probability	1	Software	40	14 (35.0)
		Electronic engineering	40	15 (37.5)
	2	Software	40	23 (57.5)
		Electronic engineering	40	25 (62.5)
	3	Software	40	25 (62.5)
		Electronic engineering	40	35 (87.5)
	4	Software	40	26 (65.0)
		Electronic engineering	40	37 (92.5)
Recognizing the importance of statistics	1	Software	40	16 (40.0)
		Electronic engineering	40	14 (35.0)
	2	Software	40	24 (60.0)
		Electronic engineering	40	25 (62.5)
	3	Software	40	29 (72.5)
		Electronic engineering	40	32 (80.0)
	4	Software	40	30 (75.0)
		Electronic engineering	40	34 (85.0)

Table 3. Analysis of the probability and statistical importance per track

Type	Major	Track	N	Result (%)
Recognizing the importance of probability	Software	System integration	40	11 (27.5)
		Software development	40	13 (32.5)
		Embedded system software	40	12 (30.0)
		Multimedia and game software	40	34 (85.0)
		Business information technology	40	29 (72.5)
	Electronic engineering	Microwave and light wave	40	15 (37.5)
		Semiconductor and electronic material	40	16 (40.0)
		System and control	40	35 (87.5)
		Information communication and signal process	40	38 (95.0)
		Computer and circuit design	40	25 (62.5)
Recognizing the importance of statistics	Software	System integration	40	12 (30.0)
		Software development	40	10 (25.0)
		Embedded system software	40	12 (30.0)
		Multimedia and game software	40	28 (70.0)
		Business information technology	40	35 (87.5)
	Electronic engineering	Microwave and light wave	40	15 (37.5)
		Semiconductor and electronic material	40	14 (35.0)
		System and control	40	29 (72.5)
		Information communication and signal process	40	37 (92.5)
		Computer and circuit design	40	16 (40.0)

Table 4. Analysis of the probability and statistical importance perception by grade

Type	Grade	Major	N	Result (%)
Recognizing the importance of probability	1	Software	40	14 (35.0)
		Electronic engineering	40	13 (32.5)
	2	Software	40	22 (55.0)
		Electronic engineering	40	23 (57.5)
	3	Software	40	22 (55.0)
		Electronic engineering	40	27 (67.5)
	4	Software	40	25 (62.5)
		Electronic engineering	40	30 (75.0)
Recognizing the importance of statistics	1	Software	40	15 (37.5)
		Electronic engineering	40	13 (32.5)
	2	Software	40	22 (55.0)
		Electronic engineering	40	23 (57.5)
	3	Software	40	24 (60.0)
		Electronic engineering	40	26 (65.0)
	4	Software	40	23 (57.5)
		Electronic engineering	40	25 (62.5)

Table 5. Analysis of the probability and statistical application perception per track

Type	Major	Track	N	Result (%)
Recognizing the importance of probability	Software	System integration	40	10 (25.0)
		Software development	40	12 (30.0)
		Embedded system software	40	11 (27.5)
		Multimedia and game software	40	28 (70.0)
		Business information technology	40	22 (55.0)
	Electronic engineering	Microwave and light wave	40	15 (37.5)
		Semiconductor and electronic material	40	14 (35.0)
		System and control	40	29 (72.5)
		Information communication and signal process	40	28 (70.0)
		Computer and circuit design	40	19 (47.5)
Recognizing the importance of statistics	Software	System integration	40	10 (25.0)
		Software development	40	9 (22.5)
		Embedded system software	40	11 (27.5)
		Multimedia and game software	40	23 (57.5)
		Business information technology	40	29 (72.5)
	Electronic engineering	Microwave and light wave	40	13 (32.5)
		Semiconductor and electronic material	40	12 (30.0)
		System and control	40	20 (50.0)
		Information communication and signal process	40	30 (75.0)
		Computer and circuit design	40	15 (37.5)

Table 4 shows the analysis of the results of the questionnaire on the perception of software and electronic engineering majors' use of probability and statistics by grade. According to Table 4, it was found that software and electronic engineering majors hardly recognize the utilization of grades and statistics even when they go up to higher grades. In addition, few respondents clearly answered the subjective questionnaire on how probability and statistics are applied and used in the major field. However, the probability was found to be somewhat low in usability for fourth graders in electronic engineering.

Table 5 shows the analysis of the results of the questionnaire on the perception of track probability and statistical utilization of software and electronic engineering majors. According to Table 5, the probability is found to be somewhat less useful in multimedia and game software tracks of software, system and control tracks of electronics, and information communication and signal process tracks. Statistics were found to be somewhat less utilizable in the business information technology track of software and the information communication and signal process track of electronics. In particular, few respondents in the fourth grade responded clearly to the short-answer questionnaire on how probability and statistics are applied and utilized in the field of major track.

In particular, some electronic engineering majors cannot fully understand and access electronic engineering-related major courses just by completing probability and statistics as major courses, requiring various probability and statistical knowledge linked to system and control tracks.

4.2 Method to Improve Education

Comprehensively analyzing the above survey results, most software and electronic engineering majors were aware of the necessity and importance of probability and statistics, but they did not clearly understand how probability and statistics were applied and used. Through these software and electronic engineering education policies, it is judged that it is impossible to cultivate manpower with intelligent information-related capabilities and technologies that can play a leading role in the information age. Today, it is considered that ICT education methods for probability and statistics course management need to be improved in order to cultivate suitable manpower in the era of the 4th industrial revolution that drives Artificial Intelligence and data convergence and IT as a whole. To this end, first, the detailed track of software and electronic engineering majors that can be characterized by linking probabilities and statistics in the ICT curriculum should provide effective customized education centered on learners through subject development. Second, instructors in charge of probability and statistics must have the qualities to combine with software and electronic engineering major knowledge, and various ways of education are required to provide the most suitable learning experience for individual learners through educational methods linked to reality. Third, rather than collective textbooks that have been traditionally used, practical examples that can be linked to majors should be developed to develop textbooks suitable for the era of intelligent information. Fourth, by applying various theories and application methods related to probability and statistics to smart technology in software and electronic engineering curriculum, we intend to acquire innovative technologies of the 4th industrial revolution and strengthen its usability.

5. CONCLUSIONS

Artificial Intelligence, the Internet of Things, and Bigdata, which are new technologies that lead the 4th industrial revolution, are changing human life and social structure. The characteristic of the 4th Industrial Revolution is full-scale digitization, which can be summarized as hyperconnectivity and superintelligence, which accelerates convergence in various areas [7]. Superintelligence means that technology and industrial structure become superintelligent through the connection and fusion of Artificial Intelligence and Bigdata, and is at a time when reasonable decision-making ability is required through data analysis and processing. In other words, the core of the Fourth Industrial Revolution is data analysis and processing. In this study, for the purpose of improving the teaching-learning of probability and statistics subjects related to data analysis and processing in the ICT curriculum, first, a survey was conducted and statistically analyzed, and third, probability and statistical education plans suitable for the 4th industrial revolution were presented. Through this, probability and statistics should be taught in the ICT field software and electronic engineering curriculum in connection with innovative technologies of the 4th industrial revolution to cultivate the ability as an expert to contribute to the creation of new technologies.

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