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A Study on the Current State of Artificial Intelligence Based Coding Technologies and the Direction of Future Coding Education

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Abstract

Artificial Intelligence (AI) technology is used in a variety of fields because it can make inferences and plans through learning processes. In the field of coding technologies, AI has been introduced as a tool for personalized and customized education to provide new educational environments. Also, it can be used as a virtual assistant in coding operations for easier and more efficient coding. Currently, as coding education becomes mandatory around the world, students' interest in programming is heightened. The purpose of coding education is to develop the ability to solve problems and fuse different academic fields through computational thinking and creative thinking to cultivate talented persons who can adapt well to the Fourth Industrial Revolution era. However, new non-computer science major students who take software-related subjects as compulsory liberal arts subjects at university came to experience many difficulties in these subjects, which they are experiencing for the first time. AI based coding technologies can be used to solve their difficulties and to increase the learning effect of non-computer majors who come across software for the first time. Therefore, this study examines the current state of AI based coding technologies and suggests the direction of future coding education.

Keywords: Artificial Intelligence, Coding Technologies, Coding Education, Software Education, Non-Computer Majors

1. Introduction

AI is a technology that applies human learning ability such as learning, reasoning, and recognition to computer systems and is one of the fields of computers used to solve problems related to human intelligence. Since AI is gradually being used in more diverse fields, it is also used to easily understand and process software.

Among the open source AI application programming interface that are used in various industrial fields are Amazon's Alexa and IBM's Watson. Amazon's Alexa is an AI platform. Users can communicate with Alexa and use it as a universal personal assistant to handle music playback, alarm settings, and weather and traffic information [1]. IBM's Watson is being studied and used in a variety of fields, including spell checking and translation, AI voice recognition speakers, medical support services, finance, law, and transportation [2]. In addition, Microsoft's Cortana, Google Home, etc. provide the ability to control smart home devices using language technology that interacts with AI [3].

AI is used as an auxiliary learning tool or virtual assistant in the field of coding technologies to understand

software and create application programs. Block coding for robot control or web based software is used as an auxiliary learning tool for customized learning that enables students to respond intuitively and participate [4]. A coding tool that acts as a virtual assistant enables the user to learn how to construct a program using deep learning instead of a program structure defined by an expert so that coding operation can be done more easily by optimizing various elements of the program.

Recently, software education for non-computer majors has been actively conducted at universities. In particular, university entrants are required to take software-related subjects, and those who encounter software for the first time feel many difficulties. Therefore, it is very important to enable students to learn coding technologies more easily [5]. In order to seek improvement of these problems, this study intends to examine the current state of AI based coding technologies used for software learning or development and to suggest the direction of future coding education.

2. An Overview of Artificial Intelligence

AI is a technology used to enable computers to do things that can be done with human intelligence, such as learning, reasoning, and planning. AI can be classified into narrow AI and general AI based on the degree to which it can do work at a level similar to that of humans. AI is different when compared to humans. As can be seen in Figure 1 [6], the tasks that can be addressed by humans are quite diverse and less complicated, while the tasks accomplished by AI are quite complicated, but the scope of resolution is narrow. In addition, simple tasks accomplished by narrow AI can be extended to complex tasks that can be accomplished by general AI [6].

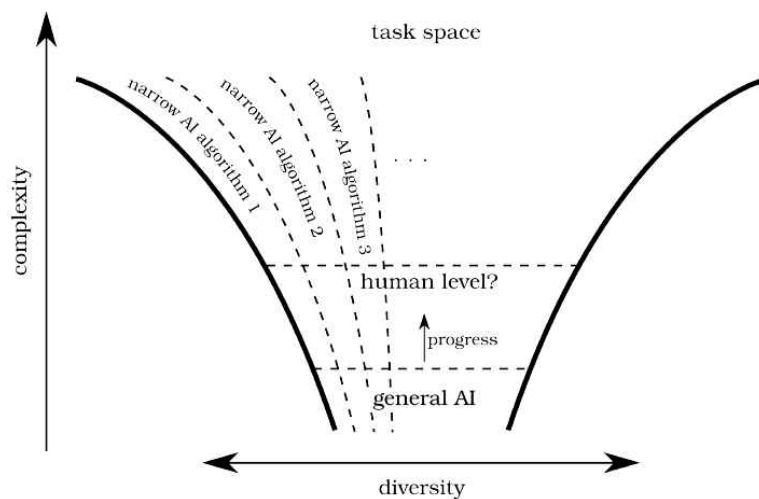


Figure 1. Relation of narrow AI and general AI

Narrow AI is applied to the processing of certain tasks using a computer and is a method that can be limitedly used to solve particular problems such as voice recognition and image recognition. This method can conduct certain actions or make decisions based on defined rules, algorithms, and data. AI based education systems belong to the narrow AI that deals with a range of educational contents. Other examples of narrow AI include self-driving cars, chatbots, and Google's AlphaGo [7].

General AI has the same level of flexibility as humans. Therefore, general AI has the ability to apply contents learned in one area to other areas extensively and to perform various functions simultaneously. This method is equipped with human-level intelligence and has the advantage of being able to actively carry out learned creations outside set rules. Technologies using general AI are developing through deep learning using

big data, but they are still at an early stage [7].

3. Current State of AI based Coding Technologies

AI based coding technologies are utilized as educational auxiliary tools using robots and coding blocks and are used as virtual assistants in program learning or development processes.

3.1 Educational Auxiliary Tools

Luxrobo's Modi is a robot module for education that learns the coding process through block assembly. This is composed of a combination of 13 types of modules distinguished as input, output, and setup parts by colors. Individual modules have different functions such as microphone, infrared, ultrasound, electric motor, and motion sensing, and an IoT robot can be made by assembling the modules [8].

SK Telecom's educational coding robot "Albert AI," which contains a "self-coding" function that enables self-learning of coding, enables users to learn various coding concepts with only a robot and a coding card without any smartphone or PC. It provides various functions such as movement, rotation, sound, function, and repetition, and also enables using various contents related to mathematics, music, and coding by interlocking with smartphone apps [9].

Cubroid, a coding block, is an educational smart toy for making robots using blocks and for easy coding programming using apps provided by smartphones. The coding apps enable easy learning of the basic principles of coding with various conditional statements such as sequential statements and repetitive statements, and also enable education related to AI robot control methods using Artibo, an AI coding block [10].

Makeblock Neuron is a programming platform consisting of electronic building blocks, as shown in Figure 2 [11]. It enables the use of advanced features such as IoT features and Microsoft Cognitive Services by using the various built-in features of at least 30 different blocks. Furthermore, in addition to light sensors, handles, and other general blocks, it has creative blocks such as camera blocks so that more creative tools can be made [11].

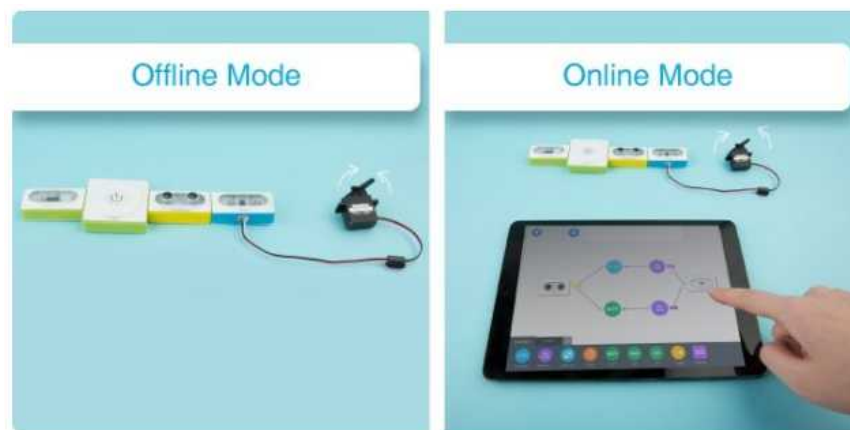


Figure 2. Coding kit of makeblock neuron

3.2 Virtual Assistants

Clever-Commit is a coding assistant system that is used to track and fix bugs in programs using AI. It estimates whether new codes are causing bugs through analysis of bugs in the past using state-of-the-art machine learning and big data technologies. In addition, it can apply reinforcement learning technologies to detect the cause of bugs and suggest corrections [12].

Kite is an AI based Python code autocomplete tool. Kite's code autocomplete feature uses a machine

learning model created by exploring the Python codes published on Github. This model learns the abstract syntax tree obtained from the codes to understand the intention and context of some codes to provide the autocomplete feature for common code patterns based on how the user and other developers have written codes in the past [13].

Sketch2Code is Microsoft's web based solution that converts drawings made by hand into HTML markup codes and converts them into HTML templates. This operates by sensing design patterns using AI, understanding drawings, texts, and structures, and then writing valid HTML codes according to the layout containing the design elements [14].

Bayou is a tool that helps users write programs. Since it operates like a search engine, when a developer has entered a few keywords, AI automatically writes code. Therefore, when coding, the developer does not write all the codes by themselves, but searches codes on Google or Github for development [15].

DeepCoder is an automatic coding technology applied with RNN(Recurrent Neural Network) jointly developed by MS and Cambridge University researchers. DeepCoder uses IPS(Inductive Program Synthesis) technology, which automatically learns program codes from given examples, and operates by searching and assembling necessary codes from StackOverflow, Programming Competition Website, etc [16].

Visual Studio IntelliCode is an AI tool that helps programming work. It learns the projects published on Github, and AI recommends the necessary functions, variables, etc. through analysis of the codes already written during coding and provides a function to detect and report frequently occurring errors. Figure 3 [17] shows an example of using C++ program.

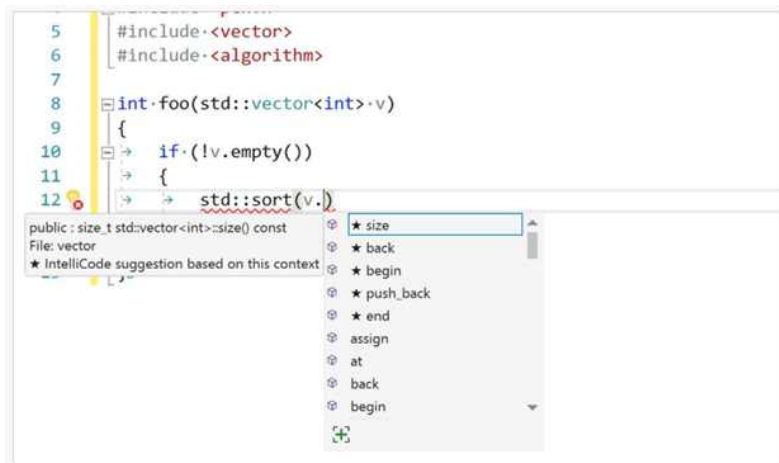


Figure 3. Example of C++ program by visual studio intellicode

4. Direction of Coding Education

The purpose of coding education is to develop the ability to solve problems and fuse different academic fields through computational thinking and creative thinking to cultivate talented persons who can adapt well to the Fourth Industrial Revolution era [18].

Currently, as coding education becomes mandatory around the world, students' interest in programming is heightened. However, new non-computer science major students who take software-related subjects as compulsory liberal arts subjects at university came to experience many difficulties in these subjects, which they are experiencing for the first time. Examples of such difficulties include fear of computers, unfamiliarity with computer languages, and lack of understanding of programming techniques. In order to solve these problems, teachers ensure that students can understand and learn the programs well through repetitive explanations and feedback and improve students' self-directed learning ability with various teaching methods such as flipped learning and PBL or improve students' problem-solving ability through group discussions [19].

Currently, however, with the development of the Fourth Industrial Revolution technologies, educational environments are changing further, and people's interest in and the necessity of online education are increasing due to the recent influence of COVID-19. There are many constraints in applying methods of interaction between students and teachers in the existing offline education environments to online education environments. In particular, although email, etc. can be used when a student wants to ask a question about a certain area in the online learning environment for software-related subjects, the feedback is not as flexible as that in an offline learning environment. Therefore, if a method to use an educational tool suitable for an online learning environment is created, the learning efficiency of students who study coding online will improve.

Although coding education aims to develop computational thinking and creative thinking, it is critical to overcome the limitations of online learning environments because it is very important to fully understand and become familiar with coding technologies.

Among the AI based coding technologies reviewed in the previous chapter, auxiliary tools are often used as methods for infants and toddlers to understand the principles of coding. Virtual assistants can be used effectively in cases where the user has expertise in programs. Therefore, methods that can be used complementarily by non-computer majors who learn software for the first time at university are necessary. The direction of future coding education presented in this study to realize such methods is as follows.

First, a process through which practice problems with different levels of difficulty are presented to students and evaluation and analysis data are accumulated to classify error items that occur frequently is necessary. Second, guidelines should be established for resolving exceptions that occur during the practice process. Third, educational tools should be designed so that they can be easily used by students unfamiliar with computers while they study coding. Finally, contents that support personalized and customized learning by students should be developed and ways to develop students' capability should be sought so that they can use the self-directed learning system well.

5. Conclusion

Recently, various application systems using AI technology have been developed, and as the importance of software increases, AI based coding technologies used as educational auxiliary tools and as virtual assistants in the process of development of programs have also been developed. Since these coding technologies are used as educational tools for infants and toddlers or are specialized for users who have basic program knowledge, ways to enable those users who encounter programs for the first time to easily use AI based coding technologies are necessary. Therefore, this study examined cases of AI based coding technologies and suggested the direction of future coding education. It is very important for students who receive coding education for the first time to fully understand and become familiar with coding technologies. In addition, students should develop self-directed learning ability and the ability to adapt to changing learning environments. In the future, guidelines for resolving the problems of exceptions should be established through the accumulation of data observed in the process of classes of students and coding technologies that can be easily used by students while they study coding should be developed.

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