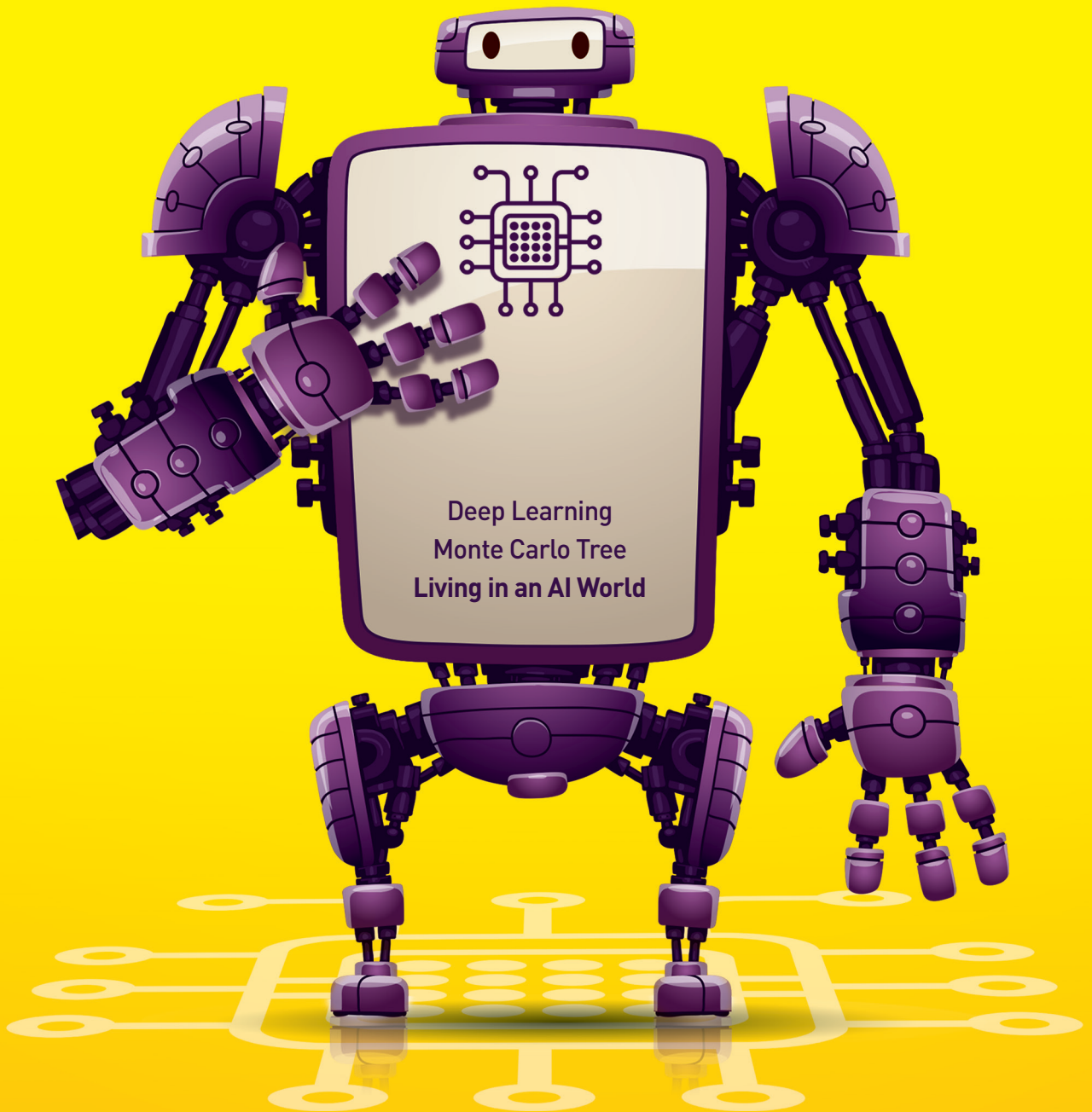


Infinite Challenge of Artificial Intelligence



How to Use
This Program

Software is changing the world. The programs installed in computers and apps that make it more convenient to use smartphones are all software. Software is in every part of our lives, so it is difficult to find areas where we are not affected by software.

The state-of-the-art science and technology that we see in the news is also helped by software. In turn, progress in math, science and technology advances software further. As such, math, science and technology are closely related with and cannot be separated from software.

These module series were created through collaboration between experts in related fields and software education, and its suitability for classrooms has been verified. As students follow teachers' direction through each module, they will be able to better understand the world that has been changed by software.



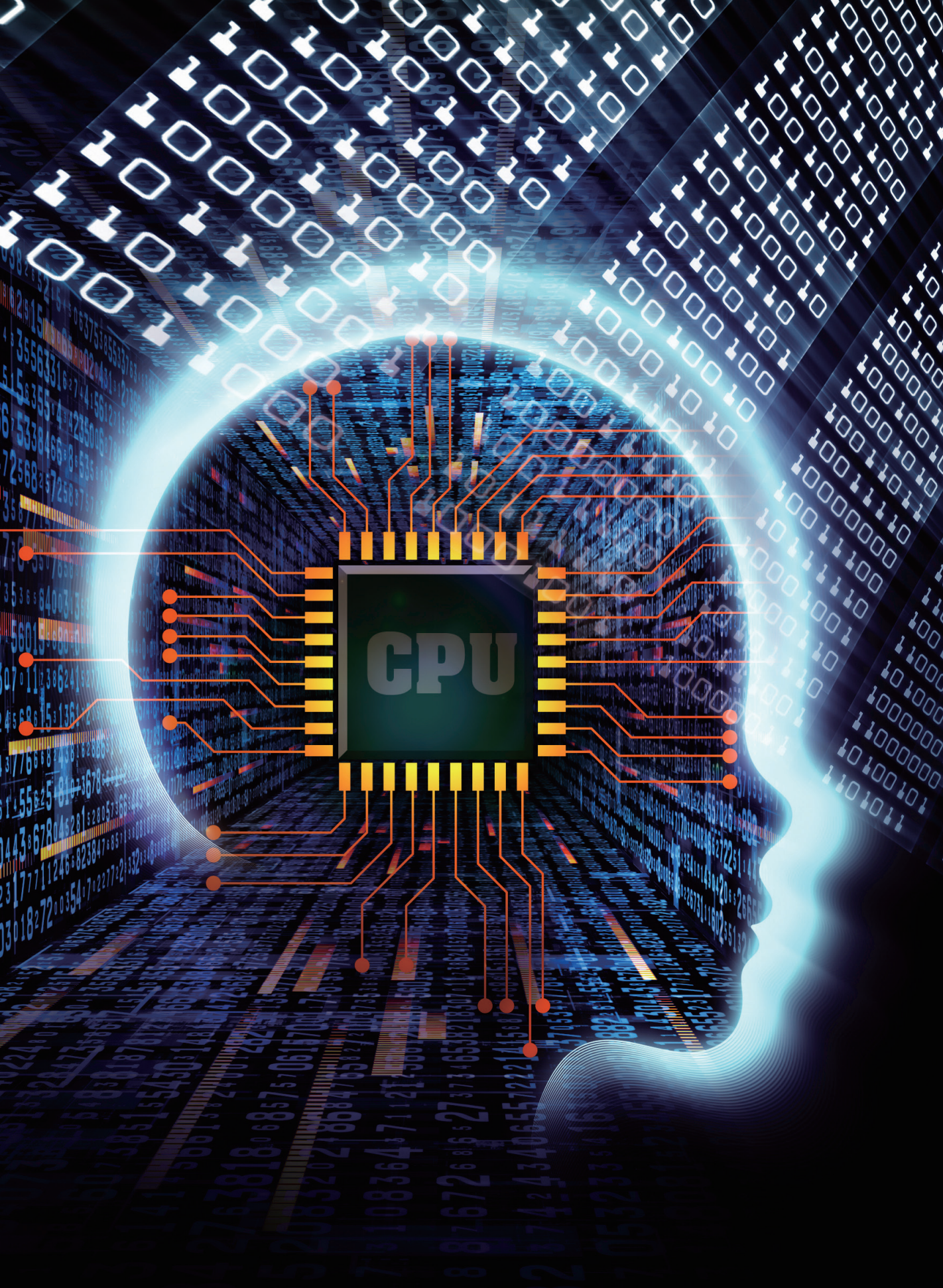
software

education module

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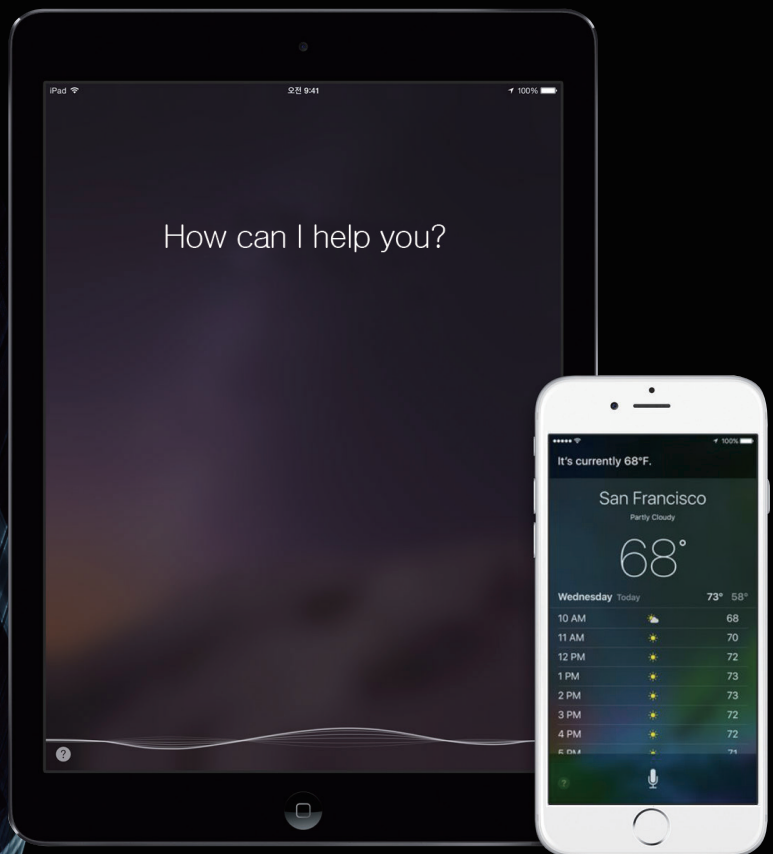
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Infinite Challenge of Artificial Intelligence!

Beating professional Go players, writing movie scenarios and playing musical instruments! These are all examples of what artificial intelligence can do today. Entering even these areas that require a high level of thinking ability and creativity, artificial intelligence may be limitless. It is still in its infinite challenge to develop such abilities further. What is artificial intelligence? And how can it easily do all of that work which we thought only humans, with our intellectual capacity, could do? Let's find out how.



THIS IS THE AGE OF ARTIFICIAL INTELLIGENCE~!

In the spring of 2016, there was a historic match between South Korea's Se-dol Lee 9-dan and Google's artificial intelligence Go program "AlphaGo". With Se-dol Lee 9-dan losing to AlphaGo 1:4, artificial intelligence drew the world's attention. However, the remarkable achievements of artificial intelligence are nothing new.

"Siri", developed by Apple, talks with its owners, makes phone calls and even browses the Internet. Google's self-driving car with embedded artificial intelligence drives on behalf of humans. And IBM's "Watson" finds information to help doctors by analyzing massive amounts of patient data, and it is believed that it will one day be able to diagnose diseases. Watson already surprised people when it easily beat a quiz champion on an American game show in 2011.

Meanwhile, artificial intelligence has also entered the art field. It is composing, painting and even made its debut as a scenario writer. The scenario writer of the short film "Sunspring", made public on the Internet in June 2016, is an artificial intelligence

system named Benjamin. Perhaps we can call the 21st century the age of artificial intelligence.

Artificial intelligence is technology that realizes the intellectual ability of humans through a computer. Due to the striking image of a self-thinking computer and that it could be smarter than humans, there are many people who worry that artificial intelligence may one day attack us. In fact, there are several films that describe artificial intelligence as a villain that makes its own judgments and destroys the world.

However, experts say that we have nothing to fear, as all artificial intelligence developed so far cannot think or make judgments on its own like humans do. But, we may need to watch out so that technology is not developed and applied in ways that harm humanity.

The father of artificial intelligence is a mathematician?!

There has been active research on artificial intelligence since the 1950s. Although ideas about arti-

Film director Oscar Sharp and artificial intelligence researcher Ross Goodwin developed the artificial intelligence writing scenario system "Benjamin". One can watch "Sunspring" by reading the QR code with a smartphone.

A self-driving car under development by Google. With diverse cameras and sensors, Google Car rides on roads without a driver. © google



ficial intelligence existed before, it has been studied as a discipline since that time.



British mathematician Alan Turing, known as the father of artificial intelligence, proposed the Turing Test to test whether a computer could think like a human. © wikipedia

In 1950, a British genius mathematician, Alan Turing, proposed the “Turing Test” to test whether a computer could think like a human. In the test, a human chats through a computer and decides if its counterpart is a human or a computer.

If it is hard to tell whether the chatting partner is a computer or a human, that program has passed the Turing Test and is recognized as true artificial intelligence. Unfortunately, no computer has passed the Turing Test yet. In 2014, the computer “Eugene Goostman” succeeded in deceiving 33% of the judges, but it was only a meaningful achievement in that it found the weaknesses of the Turing Test. The Turing Test is regarded as the first research on the concept of artificial intelligence. This is why Turing is called the father of artificial intelligence.

At the same time, there is another person who is also known as the father of artificial intelligence —

John McCarthy, an American computer scientist and mathematician. He first used the word “artificial intelligence” at a conference held at the US’s Dartmouth College in 1956, and two years later, developed “Lisp”, which is a basic computer language for artificial intelligence based on math. Lisp had an impact not only on artificial intelligence but many other areas of computing including information searching and gaming.

McCarthy predicted that computers would beat humans at chess in the 1970s. However, it wasn’t until 1997 that IBM’s super computer Deep Blue beat world chess champion Garry Kasparov.

Like McCarthy, in the 1950s, computer scientists said that artificial intelligence would develop rapidly, but the results were slower than expected. As a result, the support for research suddenly stopped in the 1970s, but as research became active again in the 1980s, today’s age of artificial intelligence began to dawn.



Garry Kasparov is the greatest chess player in history, holding the champion position for 15 years from 1985 to 2000, but he lost to IBM’s chess program Deep Blue in 1997.

INFINITE CHALLENGE OF ARTIFICIAL INTELLIGENCE~!

AlphaGo was able to beat Se-dol Lee 9-dan because of “deep learning”, which is based on self-learning. Deep learning is a machine learning method where a program learns on its own through repeated failure and success, and the computer is given a large amount of data to find general rules among the data.

Deep learning, learning on its own

In 2012, Google taught artificial intelligence to distinguish cats by applying deep learning methods. How? The research team showed the artificial intelligence program 10 million Youtube videos. Then, the program started to find rules by looking at the titles of the videos and the tags below them together with the videos themselves. As a result, it set the standards that cats are animals covered with hair, with pointy ears and whiskers beside their mouths. Using these standards, the program reached 75% accuracy in distinguishing cats from looking at pictures of animals.

Google holds an annual competition for image analysis by artificial intelligence. This competition challenges artificial intelligence computers to quickly categorize one million photos into 1,000 categories, with humans categorizing photos with around 95% accuracy. With the accuracy of the winning team of the 2016 competition at 97%, we can imagine how far today’s artificial intelligence has progressed.



Google’s artificial intelligence system AlphaGo that played against Se-dol Lee 9-dan built its Go ability using self-learning methods of repeating failure and success.

So, what was AlphaGo’s deep learning method? First, AlphaGo went through 160,000 records of games and around 30 million intersections so that it reached the Go ability of Amateur 3-dan. Records of games are the records of one match of Go that shows every move in order. So, if you look at records of games, you can learn the skills of Go. Intersections are where Go stones are placed. After reaching a certain level, AlphaGo practiced games on its own based on a huge amount of Go data. At first, improvement might be trivial, but after repeating 100 and 200 matches, its skill developed exponentially. At some point, AlphaGo mastered its fighting ability on its own and reached the highest amateur level.

By introducing the hidden weapon of the “Monte Carlo Tree Search”, it reached the skill level to beat

even professional players. A Monte Carlo Tree Search is a skill to calculate where it should put Go stones for a higher win probability.

Go is a game where two colors of stones — black and white — expand their respective territories on a grid board of 361 intersections. So, there are 361 intersections where the first black stone can be placed, and there are 360 intersections for white, which takes the next turn. Therefore, the number of the first combination of black and white turns would be $361 \times 360 = 129,960$. If you also consider the second black stone, there are more than 46 million possible cases of the first three Go stones placed on the board.

Like this, there is a countless number of possible Go games if calculated through to the end. As a result, even if one calculates really fast, it is impossible to place a stone on the most favorable intersection after considering all possible cases. Therefore, the key to the Monte Carlo Tree Search is calculating which intersection will result in the highest possibility of winning based on past games.

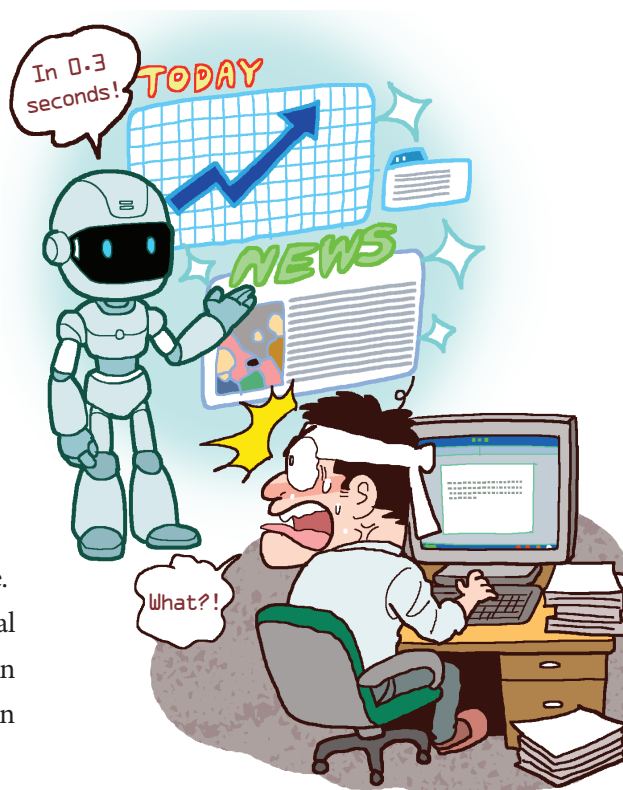
Do you know about robot journalists?

Artificial intelligence's challenges do not stop there.

Have you heard of robot journalists? Financial News, an economy-specialized media outlet, began publishing articles on stock market news written

by artificial intelligence robots from January 2016. When the stock market closes, the robot journalists write articles in 0.3 seconds using the data related to the stock market, although it uses pre-arranged basic sentences.

Overseas, robot journalists are writing news not only on the stock market but also sports matches, weather and disasters, etc., based on data. Although robot journalists cannot write in-depth analysis articles yet, if they continue to learn vocabulary used in previous articles based on deep learning technology, they will also be able to write storytelling articles where emotion is reflected.



PART 1

Recommended target

Elementary creative experience activities

Relevant subjects

Practical course, elementary school

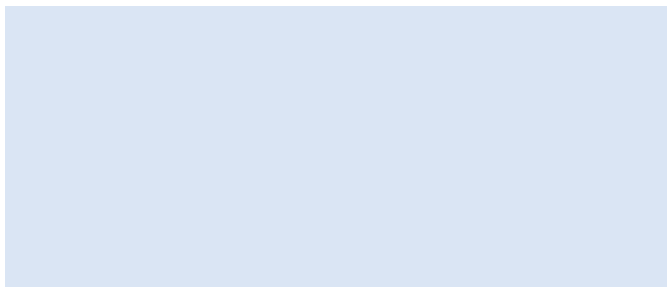
Deep Learning, Learning through Repeating

One of the key technologies of artificial intelligence is “deep learning”, which is how computers learn through repeating failure and success based on a huge amount of data, just like humans learn new things through seeing, listening and experiencing. Deep learning is used the most in image analysis, which recognizes objects through countless practice repetitions of distinguishing whether a photo is of an apple or grapes, a dog or cat, etc. Current image analysis through deep learning is at the level of not only distinguishing a person’s face from many other objects in a photo but also finding out whose face it is.

To make a smart computer, understand the computer first

Let’s search “apple” through a search engine and find photos. They all look slightly different, with some apples being red or green and with or without leaves. Yet, we all quickly recognize it is an “apple” by looking at the photo. As many characteristics of an apple — its shape or color — are comprehensively in our brain, even with some traces of worm holes in the skin of a red apple, we recognize it is an apple.

However, if we need to explain what an apple looks like to someone who has never seen an apple, what should we do? Assume that the person can only read text, and describe an apple in words without using pictures in the empty box below. Do not describe its taste or fragrance, only explain in detail what an apple looks like.



But what if that person is a computer, what should we do? To a person, we can explain with words, but how can we make a computer that only knows 0 and 1 understand what an apple looks like? To do this, we first need to think like a computer, in other words, how computers process and save data.

Data mining, mining the relationship between data

Computers' self-learning from data is called "machine learning." With more data, a computer can more accurately and quickly make judgements. If you not only collect data but also add tags such as "success" or "failure", the data can play an important role for computers to make judgements later.

For example, if there is a lot of data with "success" tags by answering "yes" to the question of "Is it an apple in this photo?", a computer may be able to distinguish apples easily. And if related content such as "apple-red color" and "apple-round" is found among the data, this will also be helpful in distinguishing apples. Finding meaning such as success or failure among data and also making connections between data is called "data mining." Humans can learn about diverse topics in various ways based on the venue, time and environment. However, computers can learn only based on their programs designed by humans in the first place. But, computers can learn at an incredibly fast speed without resting, day and night, and can show results of their learning that go beyond those of humans, as in the case of AlphaGo beating Se-dol Lee 9-dan.

People were surprised by the result of the AlphaGo match because Go, unlike other games, requires very comprehensive learning. As the match proved that artificial intelligence can be

+ Does a computer only know 0 and 1?

We can see almost all the information we need, like in a complicated game screen or news article, from a computer screen. We can also write and paint freely. However, computers can only distinguish between 0 and 1, just like appliances only have an on and off switch. So, computers process and express all information as 0s or 1s. For example, although it looks like the letter "a" or number "20" to us, a computer recognizes them as 01100001 and 0000000000010100.



+ What is image abstraction?

It means simplifying problems by dividing an image into small pieces, removing unnecessary parts and only taking the characteristic pattern. When the problem becomes simple, it gets easier to solve.

Examples of abstraction

- ① Explain how a bicycle works only with handlebars, pedals and brakes
- ② Name dishes with common characteristics all together as “bibimbap”, “bulgogi” and “kimchi”.

used beyond the limited areas we already know, such as in areas requiring comprehensive thinking, it's no wonder that it took everyone by surprise.

Deep learning and image abstraction

Diverse artificial intelligence techniques were used in AlphaGo, and one of them was “deep learning”. The concept of deep learning is actually a little complicated. Here, we will try to understand the concept of deep learning as we look at how computers distinguish images.

The following images are modifications of photos taken of objects. Let's try to guess what the original photos were of. Choose what you think was in the original photo from the bottom layer and connect it with a line.



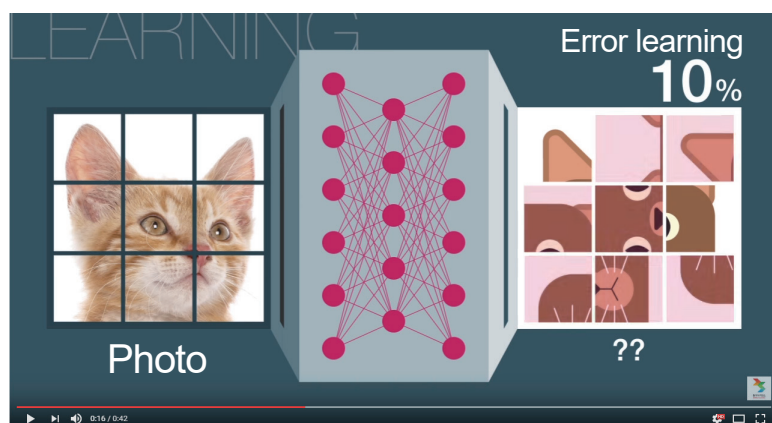
The first photo is a starfish, the second is a baseball and the third is guitar strings. Like this, taking the characteristics of an object and simplifying them is called “image abstraction”. Computers can distinguish images through the process of image abstraction.

Three stages of distinguishing images

Now, let’s take a closer look at the process of a computer distinguishing images with the example of a cat photo.

In the first stage, a computer divides the image into small pieces. The smaller the image is divided, the more accurately the computer can distinguish it. It can be divided into as few as two pieces or as many as dozens or even hundreds. The second stage is where the computer finds the characteristics and rules from the divided image and puts the “tags” mentioned above on the data. The third stage is the process of checking whether the answer we want is found by gathering the image pieces back together again. The computer gives a score as to whether it can answer “yes” to the question “Is it a cat?” when the eyes, nose, mouth and ears data of a cat is gathered. If the score is high, the computer recognizes the combination as a cat, and if the score is low, the computer recognizes the combination as not being a cat.

As such, computers distinguish images through the deep learning process of dividing an image into pieces, finding each characteristic and rule and combining the pieces back together again into the image.



+ Closer look at deep learning



Use the above QR code to see how computers distinguish cat images through deep learning.

Activity ①

How does a computer distinguish dog and cat?

To distinguish images through deep learning, we first need to find rules from many given images. To do this, we divide an image into very small pieces and simplify them by extracting each characteristic. This is called “image abstraction”. With more stages of image abstraction, the accuracy in distinguishing images increases.

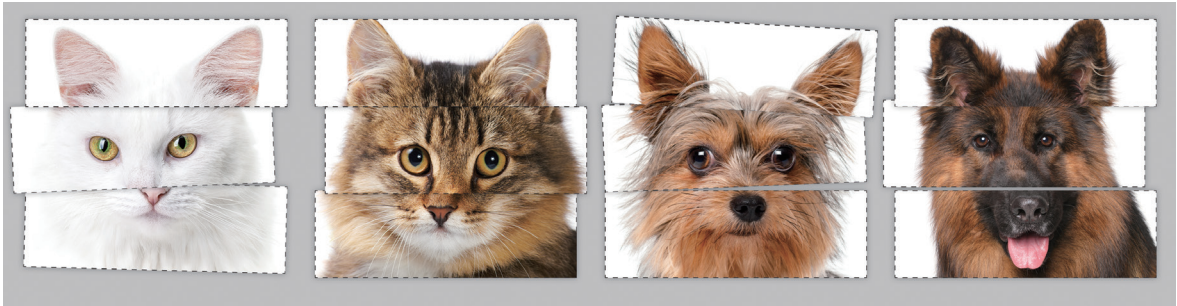
Here are some photos of cats and dogs. Cut each into three pieces and compare what is common and what is different between each piece. With more photos and smaller pieces, the accuracy increases.

What to prepare Activity material 1—①, scissors, tape, pen

Activity

1

Tear out the learning material and cut it following the dotted lines.



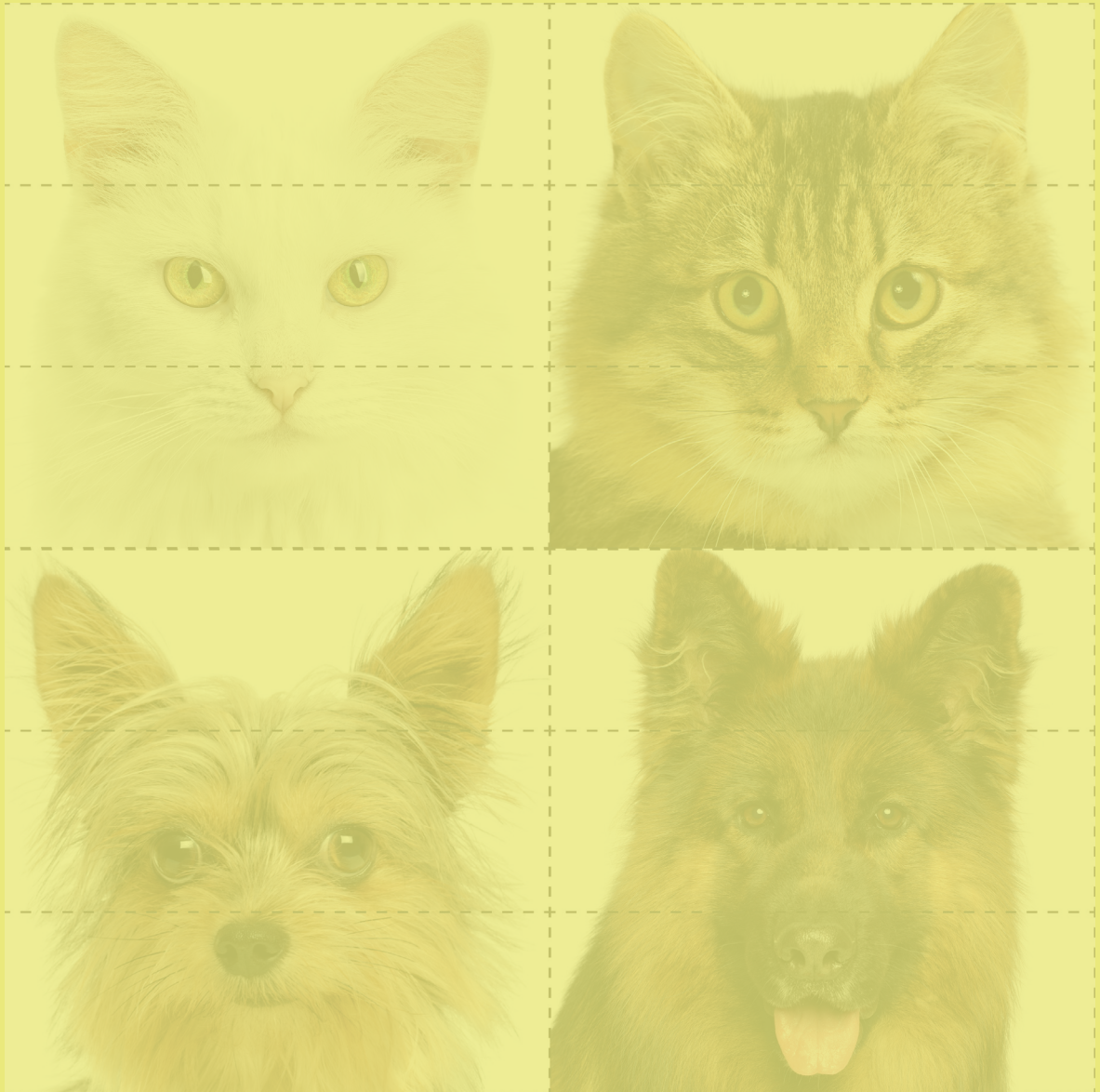
2

Mix the photos cut into pieces.



Cut the images along the dotted lines and mix the cut pieces.
Is it possible to distinguish the characteristics of a cat and a dog when the
images are cut into small pieces?





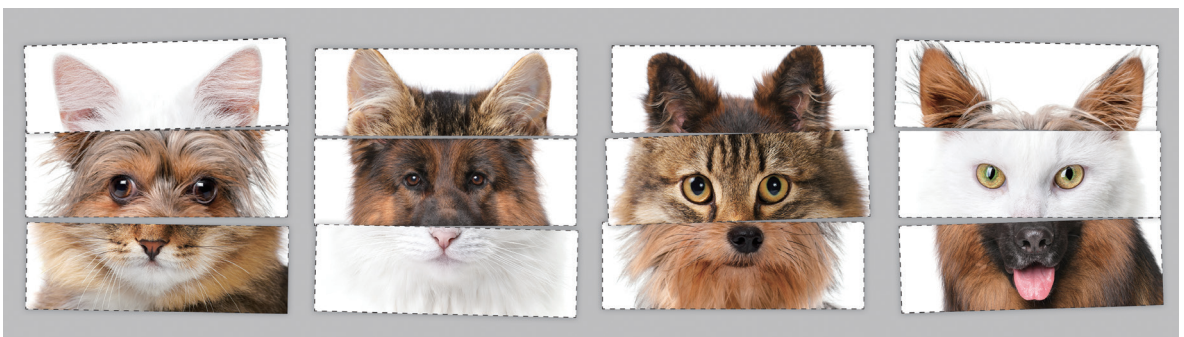
- 3** Gather pieces of similar shapes such as ears, eyes and nose/mouth.



- 4** Discuss the characteristics of cats and dogs with your partner and list them for each part.

Category	Characteristics	
	Cat	Dog
Ears		
Eyes		
Nose/ mouth		

- 5** Combine the ears, eyes and nose/mouth pieces together to make animal faces.
Make as diverse pictures as possible and give scores to the question “Is it a cat?”
The closer it looks to a cat, the higher the score.



- 6** Take only the animal faces with a score of 8 or higher. In deep learning, only the combinations with high scores are remembered as a cat, and accuracy improves with countless repetition.

PART 2

Recommended target

Elementary and Secondary Curriculum

Relevant subjects

Number of cases and probability, 6th grade, elementary school

Probability in math, 2nd grade, middle school

Monte Carlo Tree Search

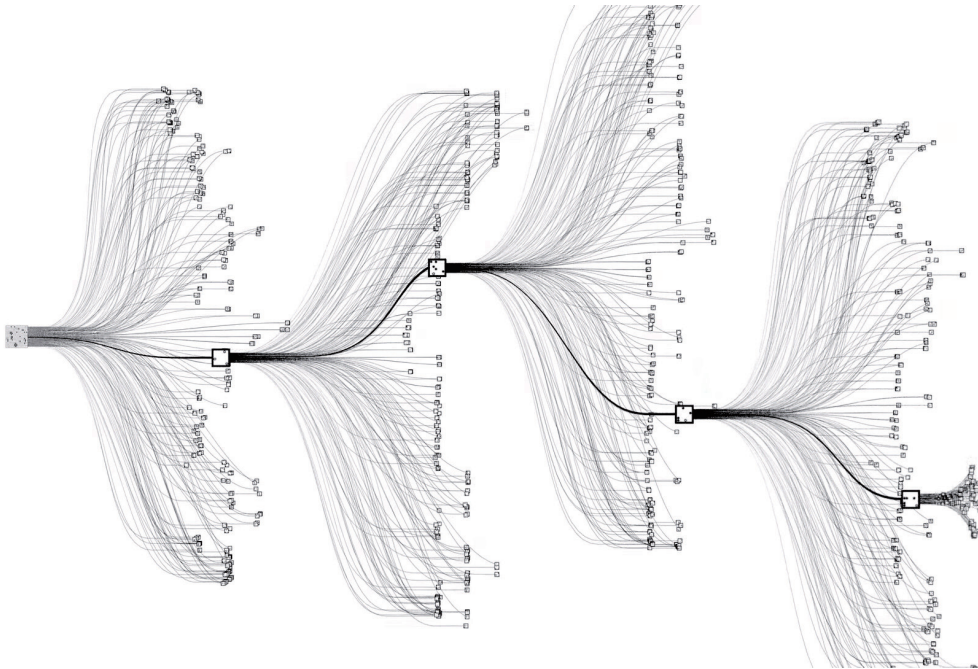
In 1997, IBM's chess program "Deep Blue" beat world chess champion Garry Kasparov. In 2011, "Watson" won a quiz show, finishing far ahead of the other two players. In board games with rules like chess or in trivia games that require extensive knowledge, computers have already overtaken humans.



IBM's artificial intelligence computer Watson participating in a quiz show in 2011. Watson even understood questions based on metaphorical expressions. © IBM

However, Go is a complicated universe that computers had not dared to enter for a long time. For a computer to beat a human in Go, it needed a different strategy from the fast calculation of Deep Blue or the vast knowledge of Watson. It needs both, in other words, "smart and quick calculation".

Finally, Google's AlphaGo challenged the Go community with its key strategy of "Monte Carlo Tree Search". The result of the challenge was victory by AlphaGo! AlphaGo's strategy worked and AlphaGo won the title of Go champion. What is a Monte Carlo Tree Search, the hidden weapon of AlphaGo? Number of cases in a board game



Conceptual map showing the number of cases in a Go game. In Go, as there is a huge number of cases for playing stones, it is impossible for computer to calculate and process it. © google

Number of cases in a board game

In a chess game between a human and a computer, when the human moves first, the computer moves its piece to where it can most likely win after considering all possible moves, a process it repeats until the game is finished.

Although the number of possible cases is enormous, it is not so many that it is impossible to calculate. In fact, Deep Blue could calculate more than 200 million moves every second, which is beyond human capacity.

However, with Go, there is a countless number of cases that even a computer cannot calculate. For the first exchange of moves alone, there are as many as 129,960 possible cases. Moreover, there are so many things to consider, as a



Go is a game where black and white make their territories on a square board with 361 intersections, and the one with more territories wins. Territory refers to the area surrounded by the stones of the same color.

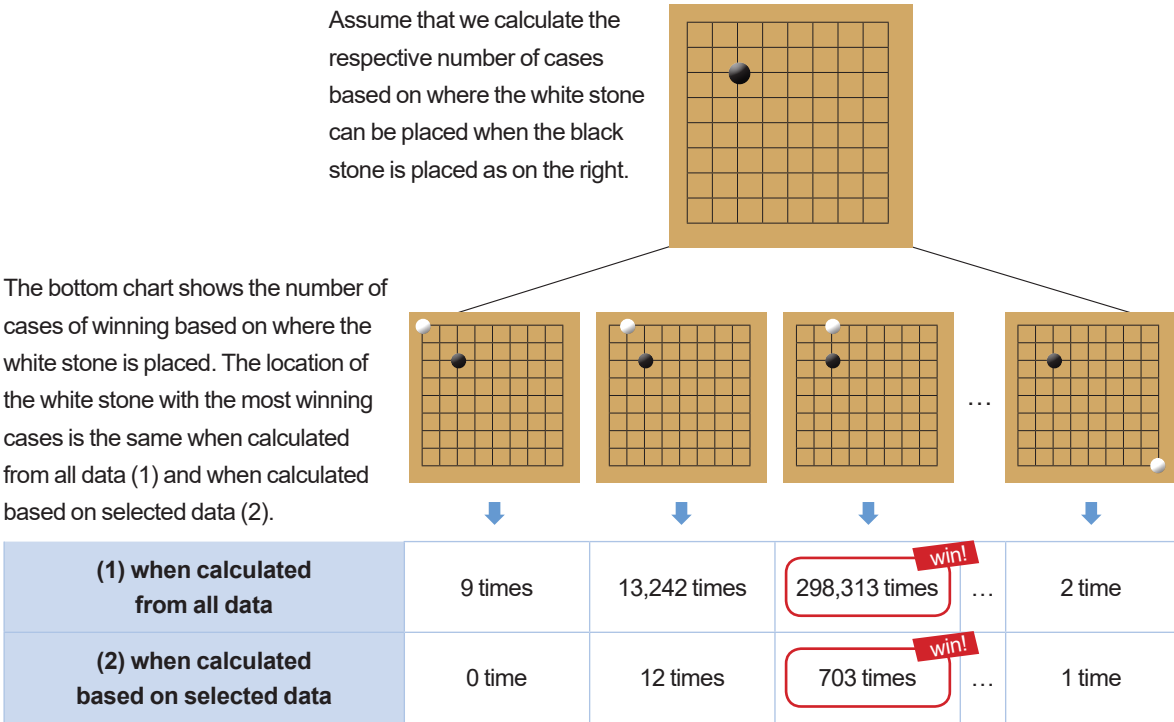
move made a long time ago sometimes plays a role later and as it is also possible to move to the spot where a dead stone was removed.

According to some calculations, the number of cases in Go is as many as the number of atoms in the universe. Therefore, no matter how fast the computer is, it is nearly impossible to calculate the entire game that will follow after a move. For this reason, it is impossible to win a game with the traditional chess strategy of making calculations by considering all the number of cases. So, computer scientists built an algorithm based on a new strategy.

Here, “algorithm” means an order or method to resolve a problem. In other words, an algorithm represents each stage that a computer goes through to perform a certain task in sequence.

AlphaGo’s strategy, Monte Carlo Tree Search

The key to the new strategy is “Monte Carlo Tree Search”. Simply put, a Monte Carlo Tree Search is a strategy of reducing the “number of cases”. As it is impossible to consider all the number of cases, the com-



puter simulates the game with random samples among the countless number of cases when its counterpart places a stone. And based on the data of countless games, it calculates where it should place its stone for the highest “probability” of winning. In this way, it calculates where the “best” spot is to place the stone each turn. You can think of it as choosing where to place the stone with the highest probability of winning instead of calculating the move that clearly wins.

Learning Monte Carlo Tree Search

Let’s look at an example of a Monte Carlo Tree Search using tic-tac-toe. The game is for two players, taking turns placing O or X on a 3x3 grid. The player who gets three of the same shape in a row horizontally, vertically or diagonally wins.

For example, let’s start a game with the X player. The player can place it anywhere among the 9 cells, but let’s assume that it was placed on ❶. Then, the counterpart places O on ❷. When the two players take turns from ❸ to ❹, on the 9th turn, a horizontal line of X is made, and the X player wins.

Then, where should the first move be made for a higher probability of winning? Let’s divide the cases into when the stone is placed in the center (1), corners (2) and on the side (3) of the square. To calculate probability, a lot of game data is needed. In Go, this would be records of games.

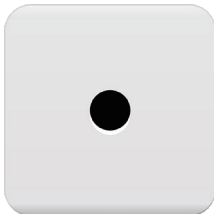
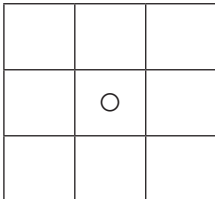
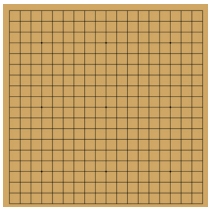
If one wins 50 out of 100 tic-tac-toe games with the first mark placed in 1, the winning rate would be $50/100=50\%$. If one wins 30 out of 100 tic-tac-toe games with the first mark placed in 2, the winning rate would be $30/100=30\%$. If one wins 20 out of 100 tic-tac-toe games with the first mark placed in 3, the winning rate would be

❷	❹	❺
❾	❶	❽
❻	❸	❸

O	O	X
X	X	X
O	X	O

2	3	2
3	1	3
2	3	2

20/100=20%. If there are thousands or tens of thousands of games instead of 100, the winning rate becomes more accurate. And if the player knows the winning rate beforehand, the player of course will start the game with the first mark made where the winning rate is the highest.

Probability of rolling a 1 in dice	Probability of winning when first mark made in the center in tic-tac-toe	Probability of winning when placing a move in Go
		
1/6	50%	?
Known intuitively	Calculate probability after actually playing many games	Difficult to calculate probability as there are too many cases

Utilizing Monte Carlo Tree Search

Using a Monte Carlo Tree Search is pivotal when it is impossible to calculate all cases because there are too many, like in Go. In fact, most of the Go programs used today utilize a Monte Carlo Tree Search. It

is also utilized when deciding when to buy and sell stocks in the stock market, where there is a vast amount of data to be analyzed every moment, and predicting climate changes with so many variables.

Although it is not based on calculating all cases, and instead on finding the best option based on random selection, both the winning rate and accuracy increase when sufficient data is accumulated, i.e. when there is sufficient learning.



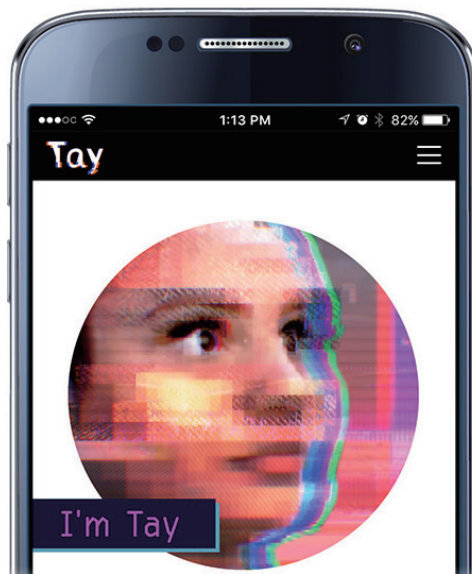
When the amount of data to be analyzed is huge including when one need to decide the time for investment in stock market, Monte Carlo Tree Search which reduces the number of cases is utilized.

Human vs. artificial intelligence

You don't need to be disappointed about Se-dol Lee being defeated by AlphaGo because AlphaGo won as a result of learning based on records of countless games by humans. It is no exaggeration to say that AlphaGo imitated the best strategies that came from the brains of countless Go players. However, as the amount of learning is so huge that humans can never catch up, we should recognize the victory by the computer that learned more.

As artificial intelligence makes judgments based on data, the results clearly vary with what data it has learned. It is like how a person's character and way of thinking are substantially affected by the environment where he or she grew up. "Tay" developed by Microsoft is a chatbot that chats with humans. However, it had to be suspended in just 16 hours from the launch of the service. The problem was that it learned what countless people said as it chatted with them "just as it is." It even learned swear words and racist words, and used them as they are with other people. This happened because, although Tay had learning ability, it did not have the ability to judge what is right and wrong.

Tay is a good example that shows that artificial intelligence is not all-powerful and instead, it just imitates humans. The excellent ability of artificial intelligence takes us by surprise, but actually the ability is something that we have had from a long time ago. It is just that artificial intelligence can synthesize and quickly process such abilities.



Chatbot Tay makes us realize that what artificial intelligence learns is important.

© Microsoft

Tay

A.I. fam from the internet that's got zero chill.

TEXT ME



Activity ②

Learning Monte Carlo Tree Search with Tic-Tac-Toe

Specifically, what is the Monte Carlo Tree Search that AlphaGo used as its strategy to beat Se-dol Lee 9-dan? Simply put, it is a way of calculating winning probability from samples randomly chosen from countless samples. To illustrate this, let's play tic-tac-toe many times with our friends and experience the computer strategy to win games.

What to prepare activity material 2—①, writing instruments

Activity

- 1 Prepare the activity material in the textbook and writing instruments.
- 2 Split into pairs and play tic-tac-toe. O makes the first mark, followed by X. The first place for O is marked. Play 30 games.
- 3 Record the results (win, lose or tie) for O when the first mark is made is 1, 2 and 3.

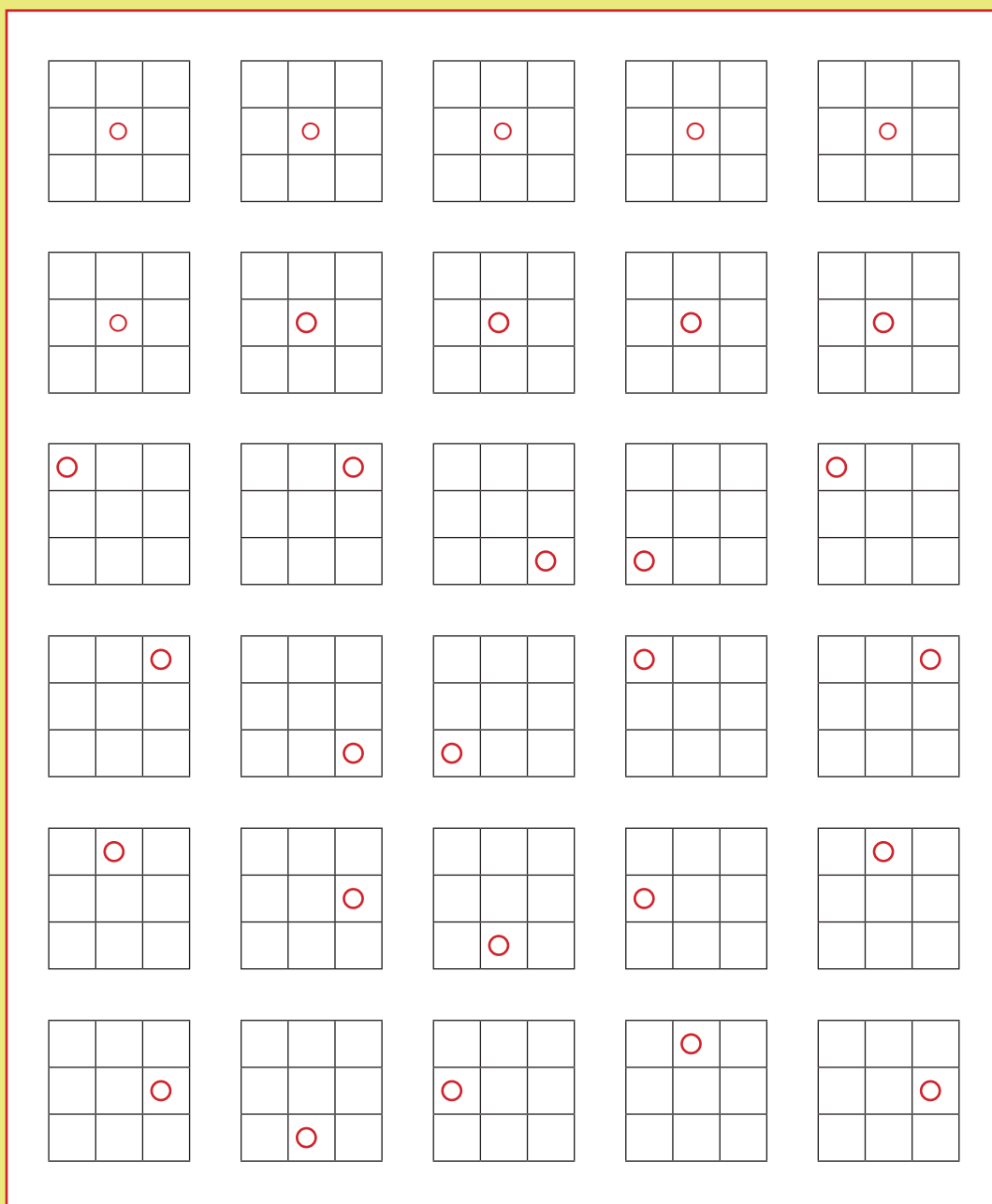
2	3	2	Spot	Win	Lose	Tie
3	1	3	1			
2	3	2	2			
			3			

- 4 Gather the game results of the entire class and calculate the winning rate. Where is the best spot to make the first mark?

2	3	2	Spot	Win	Lose	Tie	Winning rate
3	1	3	1				
2	3	2	2				
			3				

Now, the computer has learned where it should make the first mark for the highest probability of winning. Next, it selects and learns only the records of games where the first mark is made on that spot.

Decide who starts a game with your partner. The one who goes first starts with the marked O and the next person plays X.



PART 3

Recommended target

Elementary creative experience activities

Relevant subjects

Practical course, elementary school

Living in an Artificial Intelligence World

Artificial intelligence literally means “intelligence made artificially”. It is said that John McCarthy, an American scientist known as the father of artificial intelligence, used this term for the first time in 1956.

The first generation of artificial intelligence was developed for games. It started with the development of computer programs to make players feel like they were playing with another human in board games like chess. Now, we might think, “How is this artificial intelligence? It is just game.” But, even this was sufficiently surprising artificial intelligence at the time.



John McCarthy, who is called the father of artificial intelligence, first used the term. He received the Turing Award in 1971, which is known as the Nobel Prize of computer science, for his research on artificial intelligence. © wikipedia

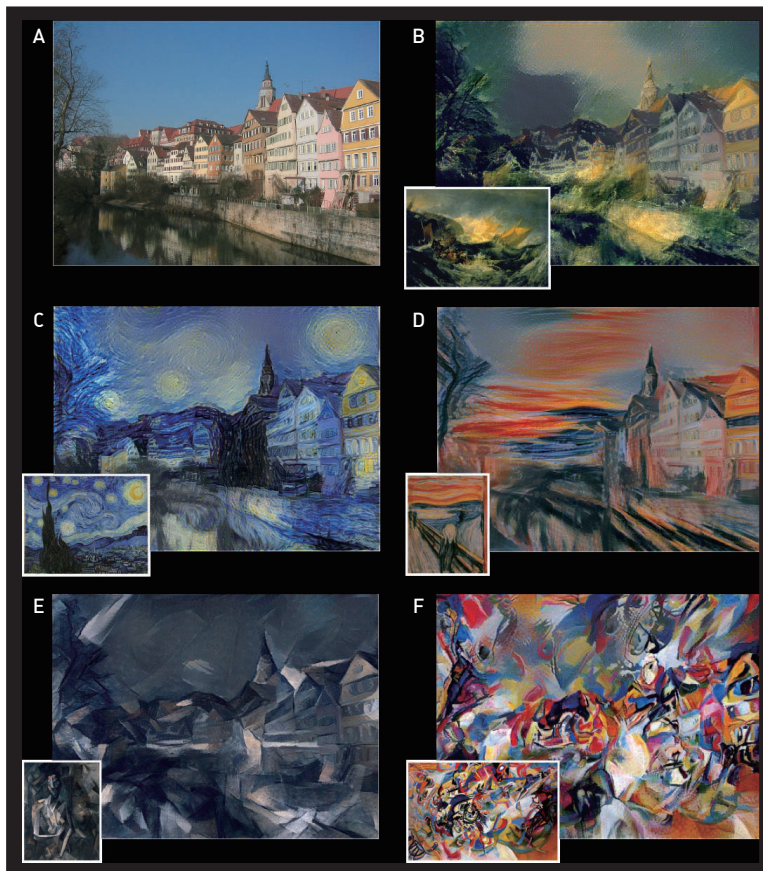
Artificial intelligence interpreted in diverse ways

As technology develops, achievements that were astonishing at first are naturally taken for granted. The same applies to artificial intelligence. So today, artificial intelligence refers to a higher level of computing than the programs that played chess with humans. Some computer scientists say that depending how artificial intelligence is defined, the objective and direction of research become totally different. In other words, the characteristics of artificial intelligence are completely different based on whether the focus is on feeling and responding like humans do or on reasoning and making judgments like humans do.

Artificial intelligence that reasons and makes judgments

AlphaGo that plays Go and Watson that solves trivia questions find ways to win games more quickly and accurately. The skills accumulated in the process are the foundation to be utilized in diverse areas of artificial intelligence going forward. This is like the “Poseok (opening)”, where you place stones to make it easier to secure territories later. In particular, in the areas of search engines, finance or advertisement, where a huge amount of data is dealt with, artificial intelligence is an incredibly useful tool.

By utilizing artificial intelligence in medicine, we can get proposals on the most appropriate medicine and treatment for the current symptoms based on countless medical data. While doctors make their best decisions based on their own knowledge and experience, artificial intelligence, instantly searching for and making judgments



A research team at the University of Tübingen, Germany, created an artificial intelligence program using a learning algorithm to paint the scenery of Tübingen (A), following the style of Turner (B), van Gogh (C), Munch (D), Picasso (E) and Kandinsky (F). It received the assessment that it well-expressed the style of the painters as in the left. © University of Tübingen

based on hundreds of thousands of clinical medical cases, can go beyond the limits of human doctors. While artificial intelligence cannot completely replace the role of doctors, it can reduce their burden and help them make more accurate diagnoses. Some artificial intelligence even imitates humans' creative activities. For example, artificial intelligence can paint similar pictures by imitating the style of a painter or write articles like journalists. While it used to be easy to know that an article was written by machine right away, as there were many unnatural expressions in articles written by earlier artificial intelligence, it has developed to the level where it is difficult to tell whether an article has been written by a human or artificial intelligence.

Artificial intelligence that feels and responds

Artificial intelligence focused on feeling and responding can easily be found in home appliances. Robot cleaners that clean on their own without direction are a good example. With diverse sensors attached, robot cleaners can quickly understand their surrounding environment. Thanks to these sensors, they can move around obstacles and stop before a drop-off. Moreover, when they are low on battery power, they can find a power outlet and recharge themselves.

Now, imagine that you are making a robot cleaner. Think about the type of artificial intelligence that would be great at cleaning. Plan a robot cleaner with artificial intelligence functions.

Robot cleaners understand their surroundings through sensors. After learning the room's layout once, it operates more quickly.



Questions	Record your ideas
Which sensor will you use?	
Where will you attach the sensor?	
With the information you received with the sensor, what will you decide?	

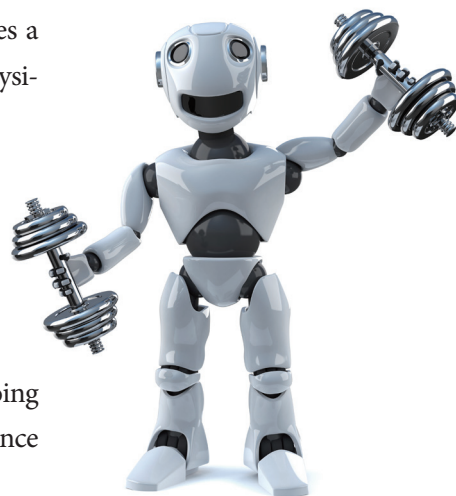
When a robot cleaner first starts operating, it goes around the room to identify the size and shape of the room and save this information in its memory. It also remembers the location of furniture in a room. As a result, it takes a long time to clean in its first operation, but once it has finished learning, the cleaning time is reduced because it remembers all that it has learned. Some robot cleaners identify their location with a camera that takes video of the ceiling.

Becoming more competent through endless learning

The greatest merit of artificial intelligence is that it becomes more and more competent as it repeats learning. When AlphaGo beat European Go champion Fan Hui 2-dan 5:0, it was surprising enough. Still, however, people thought it was too much to expect that it could beat a top Go player. However, AlphaGo kept learning through playing 30,000 games every day until it played against Se-dol Lee. 30,000 games a day. That would be impossible for a human due to our limited physical strength and concentration.

By winning in Go, where artificial intelligence had not yet beaten humans, artificial intelligence overcame its limits. Now, instead of quickly following commands based on a pre-set program, it will develop further by accumulating data.

In which area will artificial intelligence take us by surprise going forward? Imagine and write down what kind of artificial intelligence will emerge in the future.



Areas where artificial intelligence will be active	Write down what will happen

Activity 3

Robot cleaner programming

Robot cleaners not only go around the floor and clean but also identify and save the structure, size and furniture layout of the room by using many kinds of sensors and use the data in the next cleaning. This is where artificial intelligence is used.

By using Entry, let's program a robot cleaner that operates as it goes around obstacles.

What to prepare computer or laptop with Entry installed



Activity

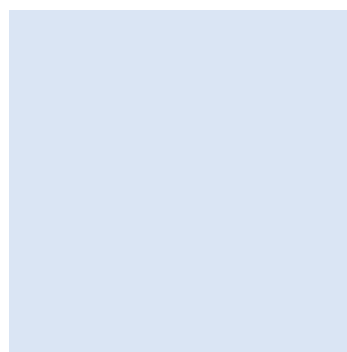
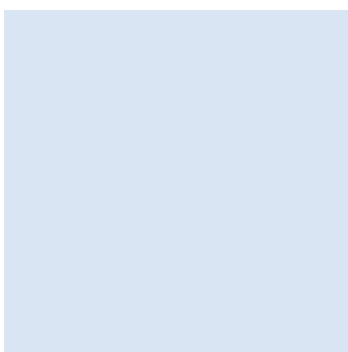
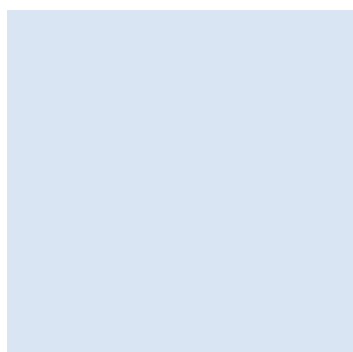
1 Activity mission

Make a project that fulfills the following conditions.

Object	Condition
Robot cleaner	While moving around, avoid obstacles and clean up tissues on the floor
Tissue	6 pieces of tissue placed randomly at certain locations
Obstacle	One or more obstacles

2 Devise a project

① Design movement patterns for a robot cleaner.



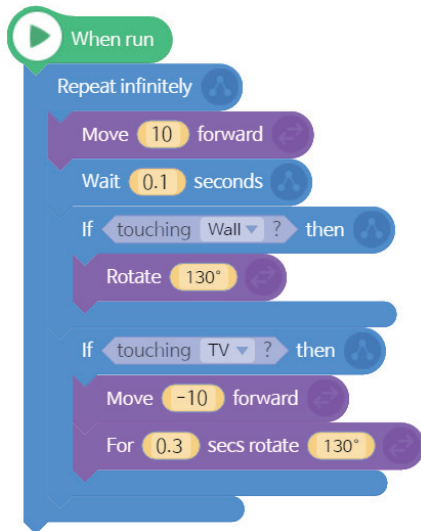
- ② Freely write down an algorithm so that the robot cleaner can clean while avoiding obstacles like a TV.

- ③ Compare the sensors of a robot cleaner and the senses of a human.

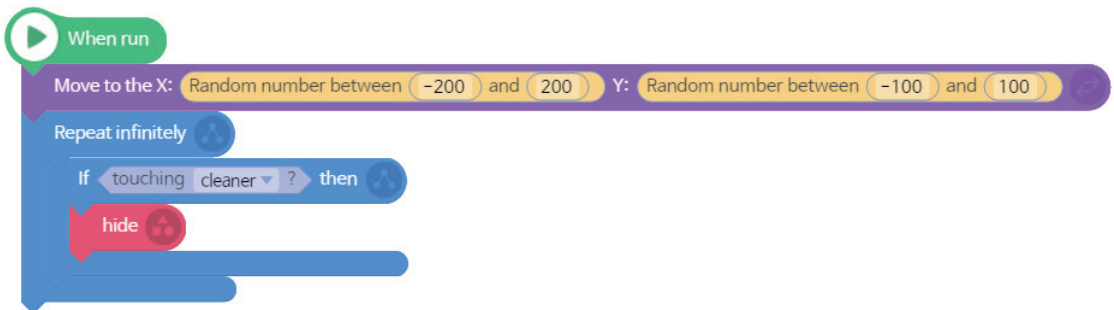
Type of sensor	Human sense	Operational principles	Similarities
Ultrasonic waves	Vision		

3 Programming

- ① Run the Entry program. Delete the Entry robot and change the background image to the floor.
- ② Appropriately lay out the robot cleaner, tissue objects and TV obstacles in the main screen.
- ③ Use Condition block so that the robot cleaner changes direction when it contacts the walls or TV.



- ④ Use Random Number blocks so that tissue objects appear at different locations every time the project is executed. Make them disappear from the screen when in contact with the cleaner.



- ⑤ Select the tissue object and copy and add it by clicking the right mouse button.
- ⑥ Execute the program and check whether the cleaner moves avoiding obstacles and whether tissues disappear when in contact with the cleaner.

⑦ Program execution screen



4 Select one of the following and change programs

- ① Measure the cleaning time of the robot cleaner by adding a stopwatch function.
- ② Add new obstacles.

5 Wrap-up activity

Write down what you felt through this activity.

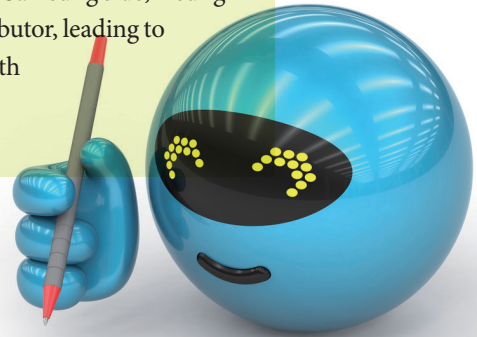
A large, empty light blue rectangular area for writing down reflections.

Activity ④

Making a robot write articles

(May 21) Samsung 6:1 Doosan

Doosan disappointed its home fans as it was defeated by Samsung 1-6 at its home game with Samsung in KBO 2015 on the 21st. Doosan had Nippert take the mound as the starting pitcher and Samsung went with Won-sam Chang. On the Samsung side, Heung-ryun Lee was in full force. Heung-ryun Lee became the top contributor, leading to Samsung's 5-point win with 2 RBIs in the top of the 2nd inning with 2 outs. Doosan gave Samsung the win by 5 runs at home, never succeeding to win over Chang-min Shim.



Instead of by a journalist, this article was written by “Pro Baseball New Robot” developed by the team of Professor Joon-hwan Lee of the Department of Communication, Seoul National University. With the development of artificial intelligence, the age of robots writing articles has dawned. Would it be possible to tell articles written by robots apart from those by humans? It is said that people cannot tell for articles that deliver simple information. By using Entry, let's make a program that automatically writes articles. While the program made here will be in the simple form of receiving inputs and outputting the results, when there is a lot more data, it can write natural articles that are like the ones written by actual journalists.

What to prepare computer with Entry installed

Activity

1 Activity mission

Make a project fulfilling the following conditions.

Conditions
① Use 4 or more keywords as variables.
② Set the background as a baseball stadium
③ Use human objects.

2 Devise a project

① Analyze baseball articles.

Underline the core information in the following article.

E.g., date, venue, team that won, team that lost, score, best players, starting pitcher, etc.

(May 6) Samsung 5:3 Nexen

Nexen, with Feierabend taking the mound as the starting pitcher, lost the game to Samsung with Cloyd by 3:5 at home. The key contributor to the game's outcome was Hyoung-woo Choi. He was the decisive factor in the team's victory with two RBIs against Nexen's Feierabend in the top of 1st inning. Nexen gave Samsung a win by 2 runs at home, never succeeding to win over Chang-yong Lim.

(May 6) SK 5:3 Lotte

Lotte, with Lindblom taking the mound as the starting pitcher, lost the game to SK with Jong-hun Park by 3:5 at home. The key contributor to the game's outcome was Brown. He was the decisive factor in the team's victory with 3 RBIs against Lotte's Lindblom in the top of 5th inning. Nexen gave SK a win by 2 runs at home, never succeeding to win over Kil-hyun Yun.

② Devise an algorithm

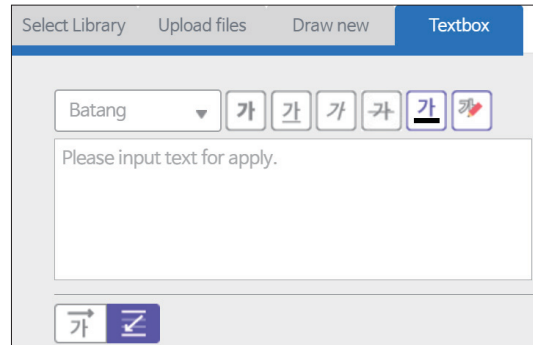
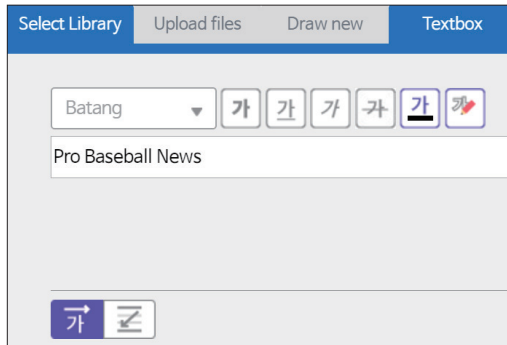
Write down the common keywords in the articles and write down the prepositions and connectives that are connected with those keywords.

E.g., from, to, and etc.

Core information		Prepositions and connectives

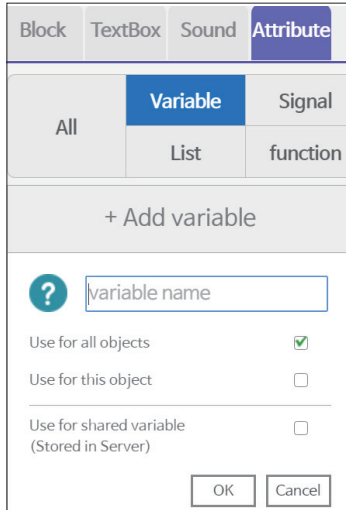
3 Programming

- ① Run Entry. Select and apply the baseball stadium as the background image.
- ② Use the **Text** menu to enter the title and articles.



- ③ Select the object of Person Asking Questions and put it at the appropriate spot.
- ④ Add words that are commonly used in articles as variables.

Make appropriate questions for the variables and save the answers in the variables.

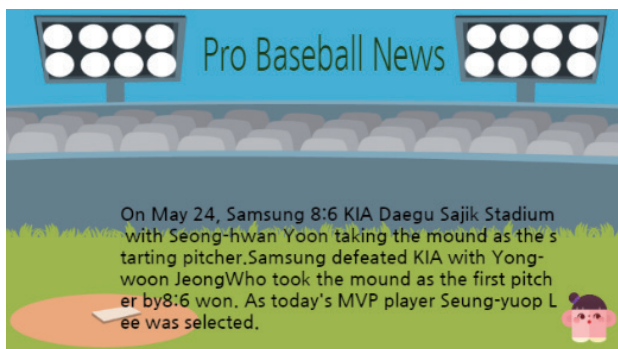


- ⑤ When receiving signals after a question is finished, write a natural sentence by connecting the value of the variables corresponding to core information and prepositions/connectives.
- ⑥ Take **Writing that** **Entry** block from **가 Text**, and select **Value of** **date** from **Variable** and put it in item. Assemble the "subsequent writing" block to make a sentence to connect.

⑦ Asking questions and completed Article Entry blocks



⑧ Run the program to check whether there are errors and revise it if there are.



Program execution screen

4 Select one of the following and change the program.

- ① Make a program to write journal entries.
- ② Make a program to write class news.
- ③ Make a program to write poems.



Artificial intelligence expert

Artificial intelligence is a technology that realizes the diverse thinking abilities of humans as computer programs. In the future, there will be computers equipped with the abilities to learn, infer, perceive and understand natural language, etc., when computer engineering and information technology develop further. Artificial intelligence experts are those who study and develop algorithms or programs so that computers or robots can think and make decisions like humans do. As artificial intelligence technologies are expected to be applied in a wide range of areas including robots, video and voice recognition, search engines, Big Data and games, etc., the demand for artificial intelligence experts is also expected to increase in the future.

What do they do?

- They make semiconductors for artificial intelligence that recognize video or voice, control robots and are used for communication or research/develop application technology.
- They research/develop programs that make computers or robots, etc., think and learn like humans do based on knowledge of the human brain and brain cell structure.

Occupations related to artificial intelligence

Software	Cloud system developer, embedded system developer, database developer, information system operator, information communications consultant, mobile contents developer, web engineer, game programmer
Intelligent robot	Voice recognition technology developer, motion recognition technology developer, medical and military robot developer, humanoid robot developer

It is highly likely that occupations related to artificial intelligence will continue to increase. It is also highly likely that completely new occupations that do not exist will emerge. This is why it is important to have experience in areas that you are good at and are interested in based on a flexible mindset.

Related majors

While computer engineering and electronic engineering departments used to be wholly in charge of artificial intelligence research in the past, they are now receiving help from diverse disciplines as they face technological limits. Today, artificial intelligence is de-

Machine
Engineering

Materials
Engineering

Electric
Engineering

Electronic
Engineering

Computer
Engineering
Departments

veloped based on the theory of “artificial neural networks”, which is based on the neural networks of living organism. For this reason, biologists and brain scientists also participate in artificial intelligence studies.

At the same time, the devices and semiconductors used in artificial intelligence are also important. This is why machine engineering, materials engineering and robot engineering departments are also related to artificial intelligence research. In our future society, it might be difficult to find areas where artificial intelligence is not used.



Required aptitude

- One should have knowledge and interest in artificial neural networks and electronic engineering, etc. Skills in basic science including math, physics and chemistry, etc., are required.
- The ability to proficiently utilize diverse computer application programs is required. And as this area is developing rapidly, one should make efforts to acquire new technology and have an attitude of self-development.
- Not only are the spirit of exploring new things, curiosity, creativity, logical thinking for problem solving and analytical ability necessary but also accurate judgment.



Expert interview

We are developing “Exobrain”, which is artificial intelligence that can go beyond general communication and share expertise. The current web search systems are based on extracting keywords and users need to find the answers they want by looking through pages even after the results are displayed. However, Exobrain can analyze whole sentence and find the exact answers to questions.

We have accumulated seven times the knowledge of Korean Wikipedia and are currently expanding, and we have also completed verification of question and answer technology that finds answers through comprehensive inference. When Exobrain is completed, it seems that a new industry will be created for diverse industrial environments through expert-level knowledge service. There will clearly be an opening of sizable market around 2020. Until then, we will develop the leading artificial intelligence in Korea that is on par with other systems anywhere in the world.

Hyun-ki Kim / Head of Data Mining Research Center, Electronics and Telecommunications Research Institute (ETRI)



Making a pot, the guardian of my plant



Written by
Hee-jun Seol (Sogang High School Teacher)



Product overview

■ Product function

A pot that regularly measures soil moisture through a moisture sensor and sends the data to a mobile phone and supplies water when the moisture is low through voice recognition

■ How it works

System of sending the value continuously measured through a moisture sensor to a mobile phone and adjusting the amount of sunlight and water through voice recognition

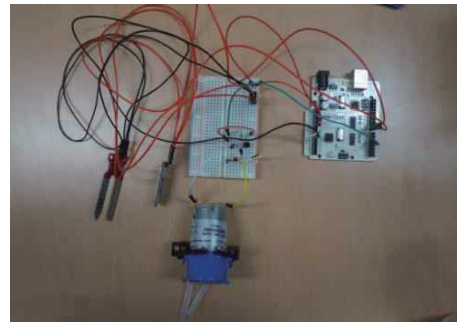
■ Product picture



How the moisture sensor is attached



How the Bluetooth sensor is attached



What it looks like when completed

■ Product structure



Measure soil moisture with
moisture sensor



Send related information
to Arduino Uno



Operate with voice
command if needed



Supply water from pumps



Production overview

- **Production time** : around 10 hours
- **Needed materials and tools**



▲ Arduino Uno



▲ Bluetooth sensor



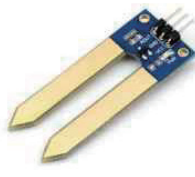
▲ Illumination sensor



▲ App Inventor (program)



▲ Pump



▲ Moisture sensor



▲ Woodlax



▲ Cutter

■ Key production principles

Measure soil moisture through a moisture sensor and realize artificial intelligence through utilizing voice recognition

Maintain the appropriate moisture level to ensure your plant grows by applying artificial intelligence functions, information-receiving sensors and voice recognition and carrying out diverse tasks following commands with the App Inventor program.

■ What requires attention in production

- ① The moisture sensor's location should be appropriately adjusted.
- ② Use an external power outlet when the motor's power is insufficient.
- ③ Learning the basic grammar structure of programming is required for the Scratch program.
- ④ Mobile phone and Bluetooth functions should work for voice recognition.

■ Required knowledge and functions

- ① How to program using Scratch
- ② Understanding of Arduino Uno and BreadBoard
- ③ How to connect the sensor and motor with BreadBoard and Arduino Uno with a cable and operate it
- ④ Understanding of the functions of diverse sensors

SW Education Module Textbook

① Artificial Intelligence

② Driverless Vehicles

③ IoT(Internet of Things)

④ Virtual Reality

⑤ CRISPR

⑥ Space Launch Vehicles

⑦ Natural Disasters

⑧ Smart Medicine

⑨ Game Engines

⑩ Sports Statistics

SW Education Module Textbook ① Artificial Intelligence

Infinite Challenge of Artificial Intelligence!

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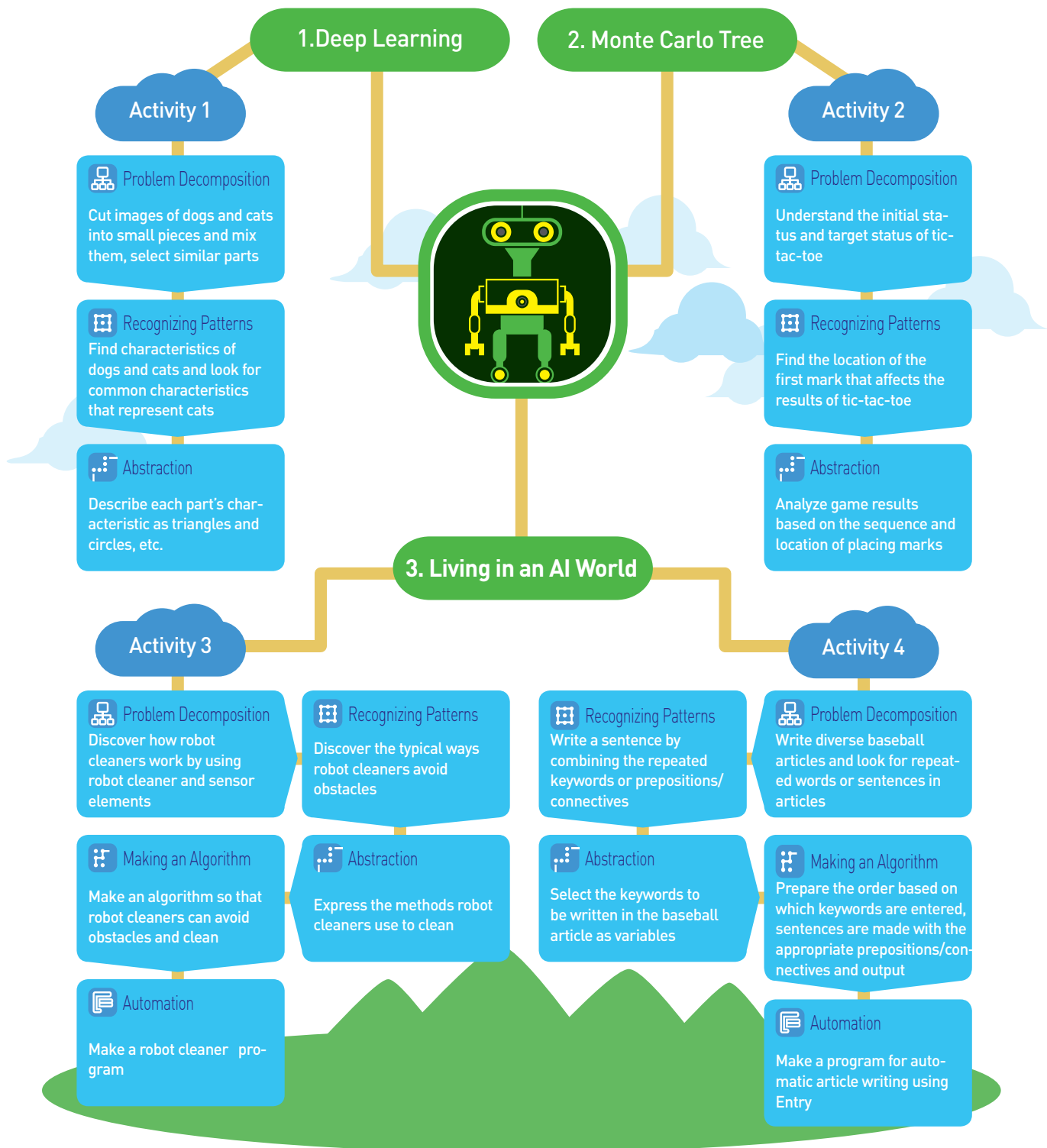
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Computational Thinking Map



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