

**SELF-CODING ARTIFICIAL INTELLIGENCE AND BUSINESS  
IMPACT**



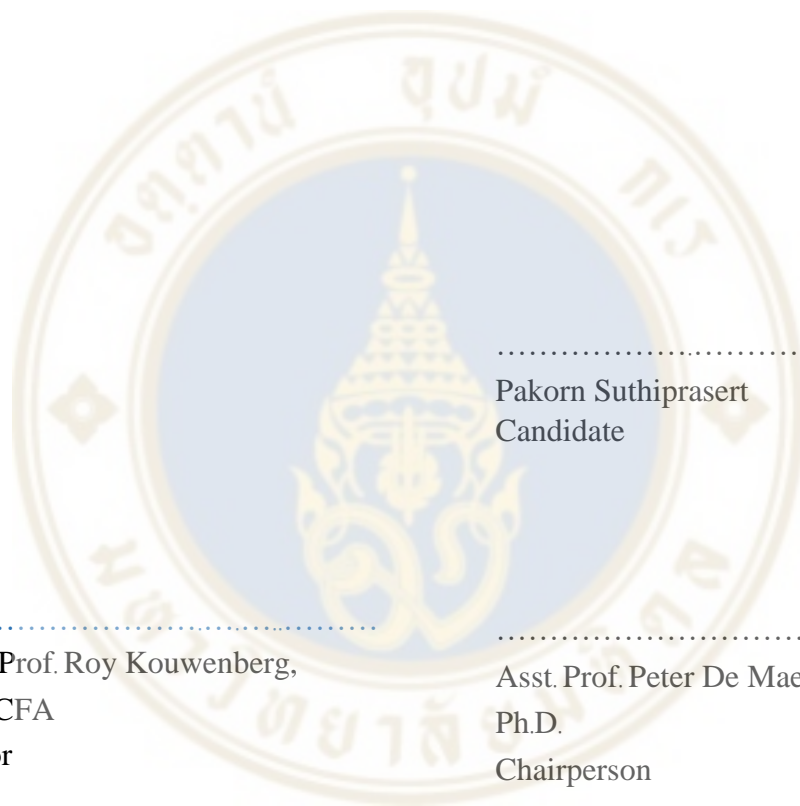
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FULFILLMENT OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTER OF MANAGEMENT  
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entitled  
**SELF-CODING ARTIFICIAL INTELLIGENCE AND BUSINESS  
IMPACT**

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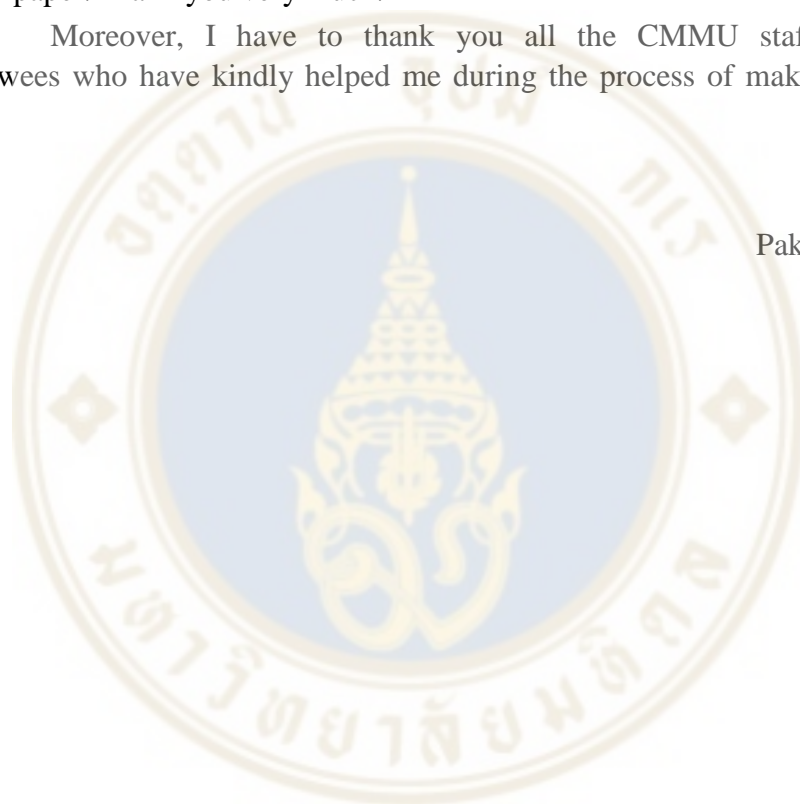
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Pakorn Suthiprasert



**SELF-CODING ARTIFICIAL INTELLIGENCE AND BUSINESS IMPACT**

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**ABSTRACT**

This research is setup to explore and understand concepts and algorithms that underline the creation of artificial intelligence that can create programs or artificial intelligence by itself. Moreover, the impact of the self-coding artificial intelligence that would occur to any particular business sector from its application in Thailand. The research uses semi-structure interview as the mean to qualitatively collect data.

The result shows that currently there are two main concepts with different algorithms towards the creation of artificial intelligence that can write programs and create artificial intelligence models. Additionally, in IT business sector, application developers will face a challenge when the self-coding artificial intelligence is widely adopted by many companies.

**KEYWORDS:** Artificial intelligence / Machine Learning/ algorithm / Thailand / Impact

45 pages

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## **CHAPTER I**

### **INTRODUCTION**

The research topic of this thematic paper is to study how Artificial Intelligence, AI, can remodify its own codes or create new codes for self-modification or new IT applications, and the potential impact upon businesses. This research looks into concepts and algorithms used for AI to do so, and effects that a business industry would encounter if the self-coding AI were to be applied in it.

Artificial Intelligence, or the AI concept, based on mathematical reasoning, has been around since the 1940s. In 1956 a group of researchers founded the field of AI research and studied about a machine that can think and understand like humans do. Unfortunately, the research was held up by the limit of computing hardware and technology at that time. Until in 21<sup>st</sup> century, the limitation has been removed by the technological breakthroughs in computer hardware and AI has become well-known, and is expected to have disruptively huge impact to everyone soon. With many research and investment poured on AI nowadays, many algorithms were created to help AI tackle a variety of problems. For example, Linear Regression is used for Machine Learning to predict values that will occur in the future given an input, or Logistic Regression is used to classify complicated data or pictures of malignant tumors. With the aim of making AI as close to the human problems solving as possible, new concepts, such as Neural Network and Deep Learning were introduced so that AI can think more like humans. Presently, AI can do many things that humans cannot, or take a lot less time instead of years. Some examples are that AI can design better products, create music, recognize patterns that almost impossible for human to comprehend, and etc. (Knight, 2017) However, according to MIT Technology Review, AI algorithms and functions are still made and tuned by humans, which unavoidably takes time and effort. In the future, it is expected that AI should be able to do programing or self-improve its own codes with



less tuning and interference by humans and there are some algorithms and concepts being applied and tested for that purpose now. Some examples of the algorithms and concepts are Genetic programming, program synthetic, dual neural networks training, deep reinforcement learning, and etc. Some examples of companies that created AI that can generate simple codes are Microsoft, StakeGAN, Google, and Gamalon, but the codes generated are still simple. Therefore, self-coding AI still has room to grow before reaching the level where human capability to write complex codes currently is.

### **1.1 Research Objectives**

This study aims to summarize the recent developments and trends about AI that can reach a higher level to where it can understand problems and be able to generate new software to solve those problems, or to create an AI itself to better solve problems. Further, the second aim is to sketch the potential consequences of these trends for businesses in the future. For example, which industries or sectors will be most affected by self-coding or self-improving AI?

### **1.2 Research Scope**

In this research, the data collection will be gathered from limited general literature research and instructors or experts who work in the field of computer science and programming in Thailand due to the fact that the number of experts in the field is scarce in the country. Moreover, experienced business people in particular industries that will face the disruptive transition from human to machine labor are included and interviewed.



### 1.3 Expected Benefits

Findings from this study will provide insights about the development of AI that can create a new software or a new AI. Additionally, this study will also explore the consequences of self-coding AI applications in businesses.



## **CHAPTER II**

### **LITERATURE REVIEW**

“Artificial intelligence”, AI, and “Machine Learning”, ML, may be used interchangeably by many but they are actually not quite the same thing. AI is a broad term used to call machines that can operate tasks in such a way that we would consider them smart. However, ML is how an AI really thinks or comes up with results, which is more like a process of deriving the outcomes. Therefore, we can think of AI as a car and ML as the engineering that makes the car do what it is supposed to do. In this thematic paper, we will, mostly, focus on ML and business impact.

#### **2.1 Machine Learning Algorithms**

Ng (2014) explained that there are so many ML algorithms that can be chosen to deal with many different tasks and problems. Some ML algorithms fit with some problems and some fit with others. How do we know which ones we have to choose. This depends on the problems we want to tackle but before that, we need to know more about them. ML algorithms can be broadly categorized into three main types: supervised, unsupervised and reinforcement learning.

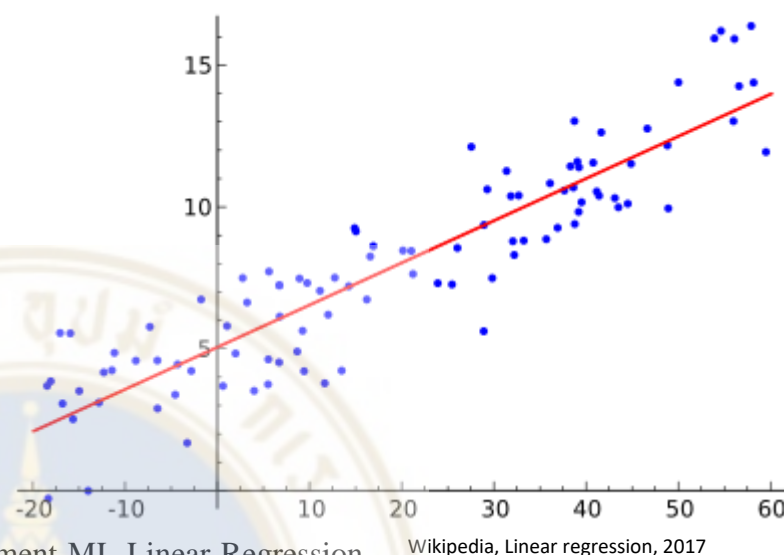
##### **2.1.1 Supervised Learning**

As the name mentioned, supervised learning type of ML needs to be instructed to learn. That means it requires input(x) and output(y) provided by humans. Then it will map those inputs and outputs by using some mathematical theories which we will discuss later. Therefore, a sufficient amount of inputs and outputs together with a suitable mathematical theory and variables, supervised learning type of ML will be able to predict outcomes or classify huge amounts of data with high accuracy, even

better than skillful and experienced humans. A couple of mathematical approaches used for this type of ML are Linear Regression, Logistic Regression, neural networks and etc.

### 2.1.1.1 Linear Regression

As in the figure, there are many dots in the graph indicating coordination of input(x) and output(y). We use a red line to draw a trend or probability of the dots. From this doing, we can tell what an output(y) is going to be when there is a new input(x). For example, we have data of houses' sizes(x) and prices(y). Then we implement ML Linear Regression



to find the most suitable red line. So when we have a new house with its size, we can predict what the price of the house will be.

How do we produce the red line?

There are Hypothesis function, Cost function and Gradient Descent that work together. Hypothesis function is the red line and in this case, a linear, the equation is  $h(x) = a + b \cdot x$ .  $h(x)$  is the output(y), 'a' and 'b' are variables that tell the position and slope of the red line and 'x' is the input. From here, we need to find out the 'a' and 'b' that make the red line best fit for all the dots. And that leads us to Cost function.

Cost function is how we find the variables, 'a' and 'b'. The equation is  $J(a,b) = \frac{1}{2m} \sum (h(x) - y)^2$ . The goal here is that we have to find an 'a' and a 'b' that make the minimum result of the equation. So when we find those 'a' and 'b', we substitute them into the Hypothesis function and we get our red line. It probably requires much time if we manually find our 'a' and 'b', so we need a helper and that is Gradient Descent.

Gradient Descent is an equation being used in a programming language to automatically find the minimum of 'a' and 'b' that is called convergence.

The lines of codes look like this

```
repeat until convergence: {
    
$$\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x_i) - y_i)$$

    
$$\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m ((h_{\theta}(x_i) - y_i)x_i)$$

}
```

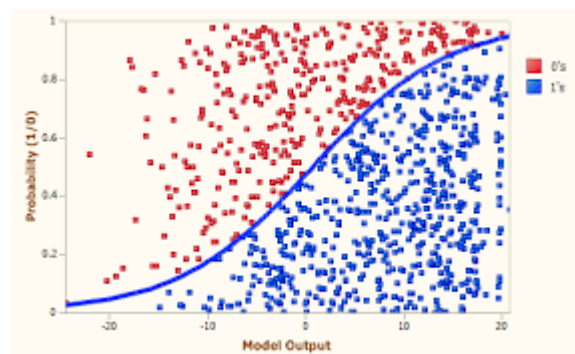
Ng, 2017

To conclude the steps of Linear Regression, first, we need to find an equation that fits with the problem that we want to solve and the equation is called hypothesis. Then we have to find the right parameters for the hypothesis so that it fit with the training set of data. It will be a time-consuming task if we find the right parameters by hand, so we use Gradient Descent, which is a way of writing codes to automatically find the right parameters.

#### 2.1.1.2 Logistic Regression (Binary)

Logistic Regression is an algorithm or a way that we use to solve classification problems, such as identifying malignant tumors of patients by classifying scanned pictures or samples of tissues. Logistic Regression is different from Linear Regression because the results of Logistic Regression are discrete values, such as 1 or 0. Binary Logistic Regression has only two results, which is 1 or 0. For example, in the case of malignant tumors, the result is that patients have cancer or not, which can also be said by yes(1) or no(0), thus the values can only be 1 or 0. On the other hand, Linear Regression is used to predict a value given an input and the predicted value can be more than two values, depending on the training set of data. For example, we want to know a price of a house given the house's size.

The figure can also show characteristic of Logistic Regression. We can see that the samples or training set data are divided into two group (red and blue dots), which is different from Linear Regression where samples or training set data are not.



Logistic Regression also have hypothesis Fusion Analytics World, 2016  $h(x)$  and cost functions.

We have to make the results to be discrete values (1 and 0) so we need decision boundary which is the blue line separating the red and blue dots. So the hypothesis and decision boundary function look like ones in the figures

$$h_{\theta}(x) = g(\theta^T x)$$

$$z = \theta^T x$$

$$g(z) = \frac{1}{1 + e^{-z}}$$

Ng, 2017

$$h_{\theta}(x) \geq 0.5 \rightarrow y = 1$$

$$h_{\theta}(x) < 0.5 \rightarrow y = 0$$

Ng, 2017

The cost function and gradient descent are as follow

$$J(\theta) = -\frac{1}{m} \sum_{i=1}^m [y^{(i)} \log(h_{\theta}(x^{(i)})) + (1 - y^{(i)}) \log(1 - h_{\theta}(x^{(i)}))]$$

Ng, 2017

*Repeat* {

$$\theta_j := \theta_j - \frac{\alpha}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

}

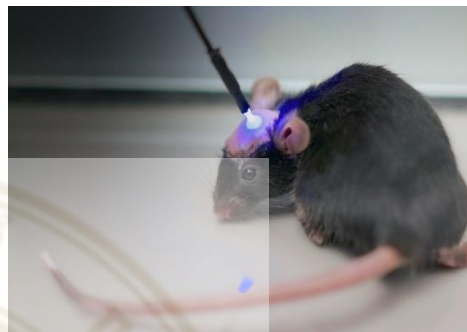
Ng, 2017

The concepts work the same as Linear Regression but the equations are modified and a bit different.



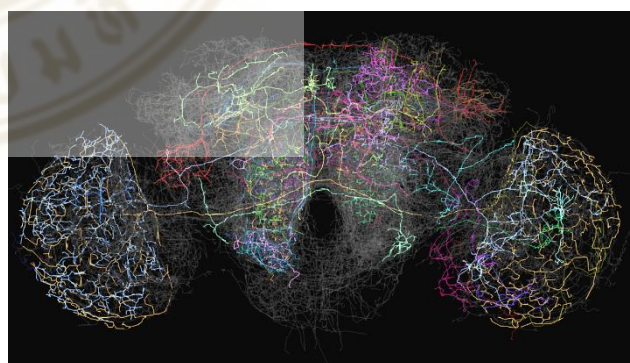
### 2.1.1.3 Neural Network

According to Nielsen (2017), neural network or non-linear hypothesis is a product of experiments on how the human brain works. The experiments tweak or change the connection between sensing organs and the corresponding parts in the brain. For example, eyes have many neurons connected together as a network to the Occipital lobe, which is located at the back of the skull, and for nose, neural network help connect it to Temporal Lobes, which is located at the side of the head. Scientists rewired the connections by redirecting a new organ or sensing device to the brain part of an experimental animal and the result was that the animal is able to perceive the signal and interpret the meaning. In other words, it could learn to use the new attached device. Another case could be Ben Underwood, a boy who lost his eyes from retinal cancer at the age of two and later had an ability to see using his tongue to make clicking noises. He, actually, was able to use echolocation to see objects around him. These are evidences that brain can learn and adapt using the same neural network with new inputs from a new organ.

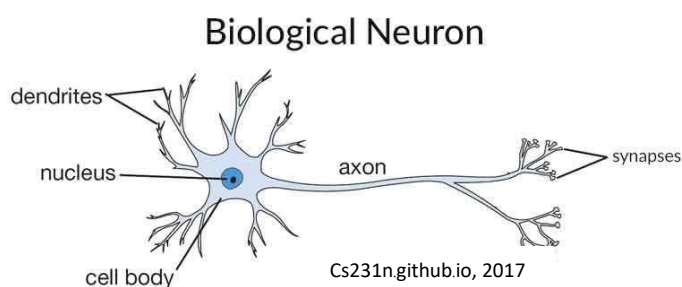


John. Carnett/Popular Science/Getty, 2017

The pictures show the complex connections of approximately 80 billion neurons in the brain. The picture of Biological Neuron zooms up close part of a neuron that consists of dendrites as signal receivers, nucleus as signal processor and synapses as signal transmitter. Many neurons



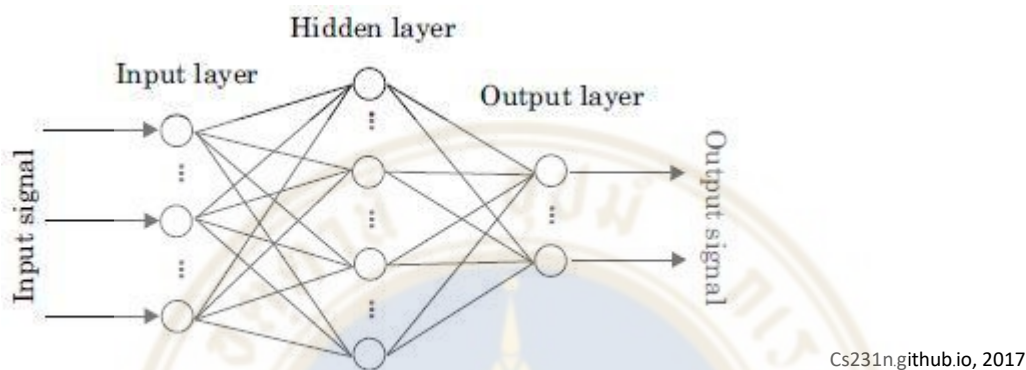
Gadget F, 2017



form a huge complex connection that can be described as layer and node relationship before reaching the brain part.

The organ, at the other end of the neural network, sends signals to the corresponding brain part. Along the way, the signals are processed by the neurons before they get to the brain.

With this architecture, data scientists create an algorithm mimicking the way brains work and become the neural network algorithm as shown in the picture.



**Figure 1. Structured chart of neural network.**

It can be seen that the circles, called nodes, represent nucleuses and the lines connecting the circles are dendrites. There are three layers, input, hidden and output layers. The input layer provides variables of the data we have. Then the hidden layer processes the data and then produces the results to the output layer. The picture shows a simple neural network that has just one hidden layer. There can be hundreds of them and each can have hundreds of nodes.

As other algorithms, neural network needs to be converted to a mathematical function, hypothesis function, and needs to have a way to optimize, which is a cost function.

The followings are examples of hypothesis and cost functions of a neural network.

$$\begin{aligned}
 a_1^{(2)} &= g(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3) \\
 a_2^{(2)} &= g(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3) \\
 a_3^{(2)} &= g(\Theta_{30}^{(1)} x_0 + \Theta_{31}^{(1)} x_1 + \Theta_{32}^{(1)} x_2 + \Theta_{33}^{(1)} x_3) \\
 h_{\Theta}(x) &= a_1^{(3)} = g(\Theta_{10}^{(2)} a_0^{(2)} + \Theta_{11}^{(2)} a_1^{(2)} + \Theta_{12}^{(2)} a_2^{(2)} + \Theta_{13}^{(2)} a_3^{(2)})
 \end{aligned}$$

Ng, 2017



$$J(\Theta) = -\frac{1}{m} \sum_{i=1}^m \sum_{k=1}^K \left[ y_k^{(i)} \log((h_{\Theta}(x^{(i)}))_k) + (1 - y_k^{(i)}) \log(1 - (h_{\Theta}(x^{(i)}))_k) \right] + \frac{\lambda}{2m} \sum_{l=1}^{L-1} \sum_{i=1}^{s_l} \sum_{j=1}^{s_{l+1}} (\Theta_{j,i}^{(l)})^2$$

Ng, 2017

In the function, there are weight and bias variables and those will be useful for adjustment of the function to fit to a given data set.

Neural network uses a technique called Backpropagation to help optimize the cost function or in other words, adjusting the weight and bias variables. Backpropagation works backward through the neural net by changing the weight and bias variables in each node of each layer so that the output is as close as possible to the training data.

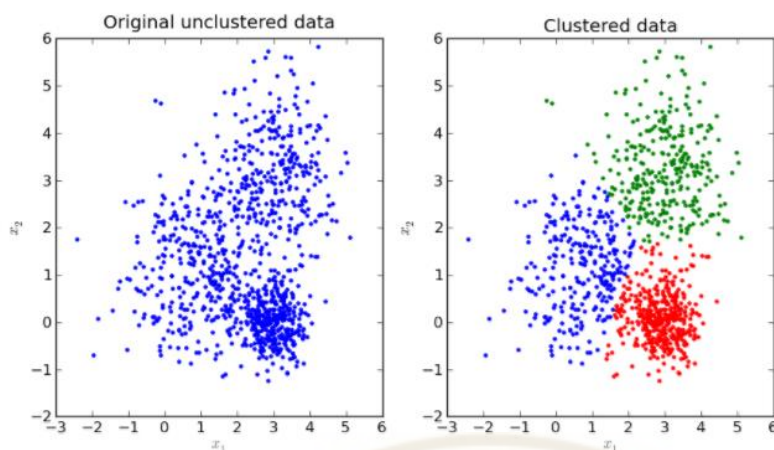
## 2.1.2 Unsupervised Learning

There are only inputs available for this type of machine learning and that means at the beginning, we do not have outputs or answers of the problems, so we want unsupervised machine learning to figure out the relationships, patterns or groups of data. Then it is up to us how we want to make use out of the outputs of unsupervised learning algorithms. A popular unsupervised machine learning algorithms is the K-means algorithm.

### 2.1.2.1 K-Means

(Trevino, 2016) K-learning algorithm is used to solve clustering problems and they are problems that need to be categorized. For example, we want to divide customers into groups based on their shopping behaviors. Elements in data set for K-learning algorithm must be numerical data because the algorithm has to mathematically calculate distances between data points.

What K-learning algorithm does is that first, it randomly put coordinates, called centroids, into a graph of elements of a data set. We can identify the number of centroids as we see fit. Then it measures all the distances between the centroids and the elements. At this stage, the elements are marked for which centroids they belong to according to their distances between the centroids.



Pathak, 2017

Next, for each centroid and its elements, the center of gravity is calculated by finding the average of all the distances between the centroid and the elements. After

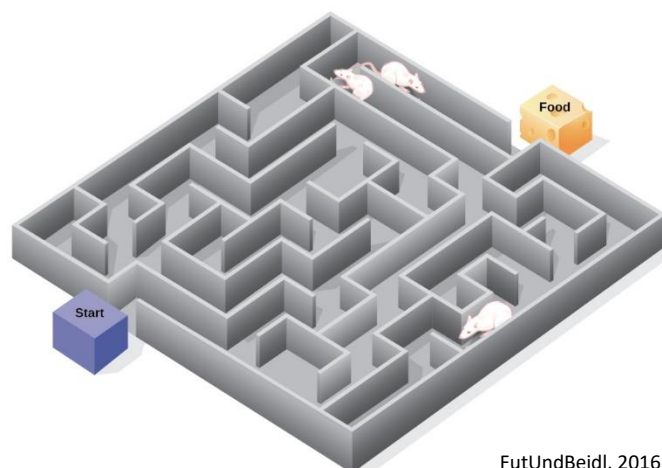
retrieving the centers of gravity of all the centroids, each will be moved to the corresponding centers, thus the centroids are moved to the center of their elements.

This process repeats itself until centroids cannot be moved or slightly moved from the previous coordination.

### 2.1.3 Reinforcement Learning or Deep Reinforcement Learning

(Maini, 2013) Reinforcement learning differs from supervised and unsupervised learnings in a way that it makes machines perform various tasks rather than forecasting, grouping or identifying data. It does not need prepared big data sets to be trained like supervised and unsupervised learning. Instead, it requires inputs and some processes for those inputs so that it can deliver desired results. The processes will help the machine learn what are the right actions and what should the machine perform.

Imagine rats in a maze trying to find the way to get to the food as demonstrated in the picture. The rats do not know about the maze when they first were put in it. In order to get to the exit and food to survive, the rats have to find out a way that lead them to their goal. They have to go along the way and decide which way to go further each turn they encounter. If



FutUndBeidl, 2016

they choose wrong, they try different path and spend more time in the maze. If they choose correctly, they get to the food faster.

We can use concepts of exploration/exploitation tradeoff, Markov Decision Processes (MDPs), Q-learning and Value learning problem for machine agents to be able to do assigned tasks.

The exploration/exploitation tradeoff uses the epsilon-greedy strategy. Epsilon is the percentage the agent will randomly take selected action rather than taking the ones to maximize the reward. The more amount the agent learns corresponds to the less epsilon value we set for, so it optimizes the result.

Markov Decision Processes (MDPs) contains

1. A set of all possible states of the agent, such as the position of a rat in the maze, dead end and cross way
2. A set of actions available in each state, such as turning left, right, U-turn and go straight
3. Transition between states. For example, the agent turns right at a cross path and end up in a new position.
4. Rewards associated with each transition. This is a numerical value, such as 0, 1 or 5. The agent will get more or less rewards depends on the position it is.
5. A discount factor between 0 and 1. This is the difference in importance between immediate and future rewards.

The goal here is that agent has to maximize the rewards.

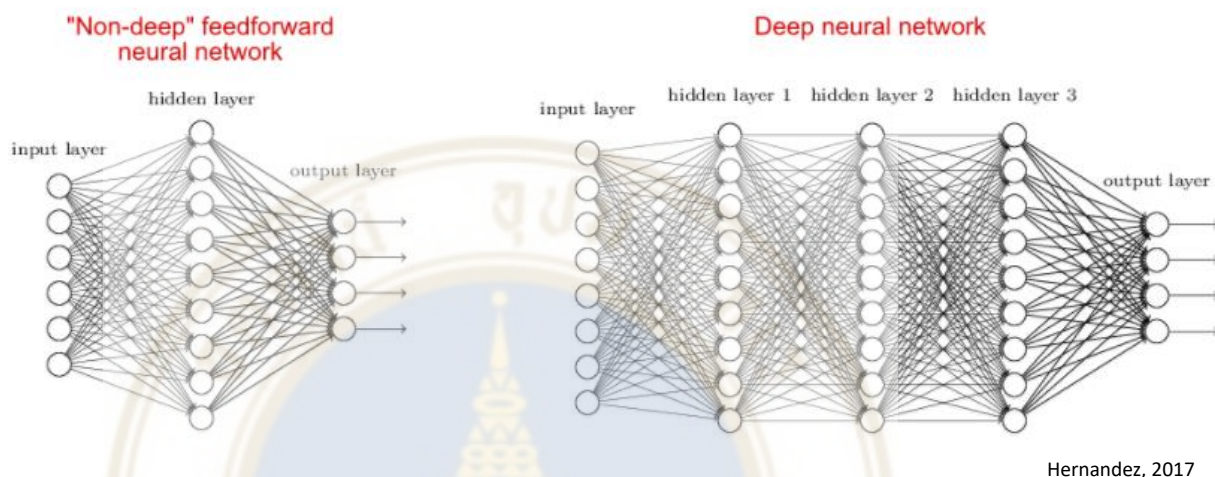
$$\sum_{t=0}^{t=\infty} \gamma^t r(x(t), a(t))$$

Q-learning helps the agent decide which action to take based on action-value function

$$Q(s_t, a_t) \leftarrow \underbrace{Q(s_t, a_t)}_{\text{old value}} + \underbrace{\alpha}_{\text{learning rate}} \cdot \left( \underbrace{r_t}_{\text{reward}} + \underbrace{\gamma}_{\text{discount factor}} \cdot \underbrace{\max_a Q(s_{t+1}, a)}_{\text{estimate of optimal future value}} - \underbrace{Q(s_t, a_t)}_{\text{old value}} \right)$$

Learning rate alpha is similar to Linear Regression, which is how aggressive the update we want it to be.

Deep reinforcement learning is actually reinforcement learning but the nodes in the hidden layer are a lot more in number because they are required for the algorithm to solve complex problems.

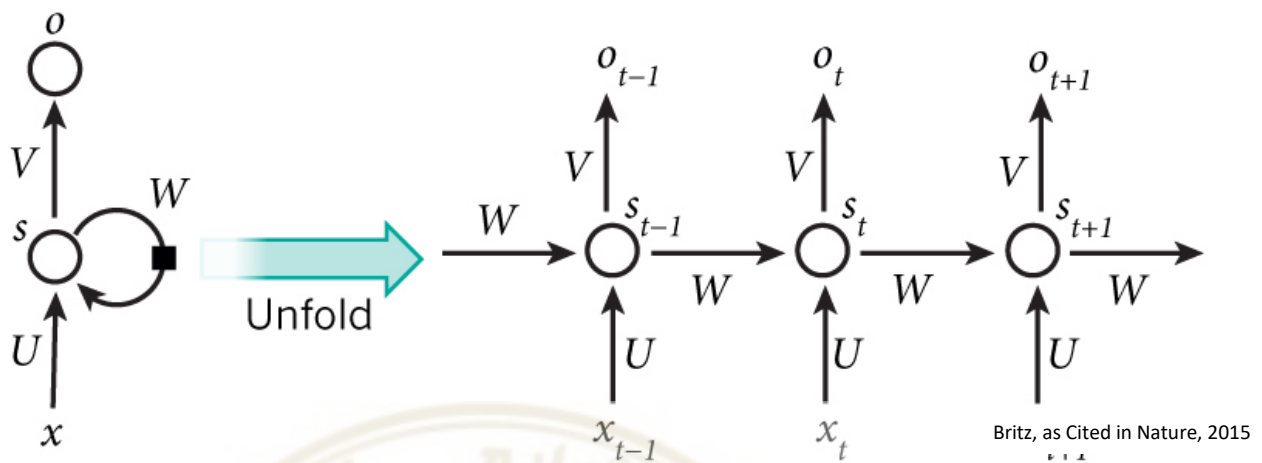


### 2.1.4 Recurrent Neural Networks

Recurrent neural network algorithms can be viewed as a technique being added into neural networks and it enhances the ability for the neural networks to remember the past values of previous calculations. It can be said that neural networks have memory by adding recurrent neural networks into them.

Typically, each node of neural network is independent, which means it only receives and calculates its input with its weight value. However, for many cases, we need nodes to calculate other previous outputs with the weight values of the calculating nodes. Therefore, recurrent neural network makes the desired action possible





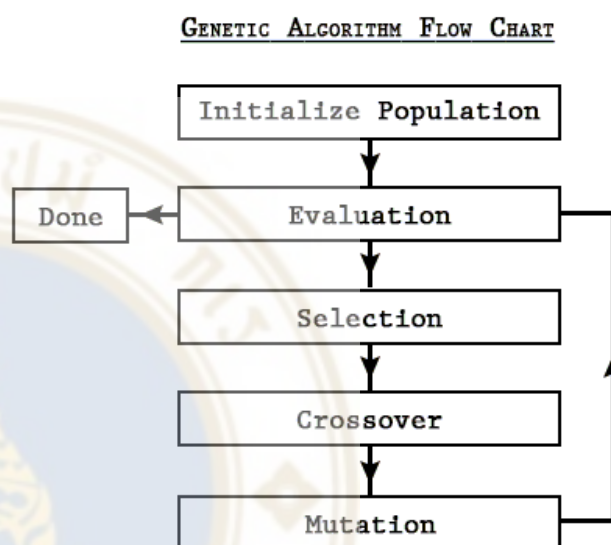
The picture above is how recurrent neural network is implemented,  $X$  is the input,  $O$  is the output,  $W$  is the weight and  $S$  is the states.  $S$  serves as the memory that contains values of other nodes. You can see that within one neuron, there are three sub neurons, which contain values of other different neurons, and they all are calculated by the weight of the main neuron.

An example of applying recurrent neural network is language prediction and generation. Assuming that we want a machine to predict a phrase based on this fragment: "Goo\_ Mor\_ \_ \_". It takes into consideration the given letters by putting them into  $S$  states and predict the possibilities of the blanks.

## 2.1.5 Genetic Algorithm

(Kanber, 2012) Genetic algorithms were derived from how organisms evolve. The evolution has gone through mating and mutation for more than many thousands years. We use the same concept of mating and mutation to apply for machine learning algorithm. Genetic algorithm can also be perceived as searching algorithm because it is a very good for optimization of problems. Flow chart of how genetic algorithm work is shown in the figure.

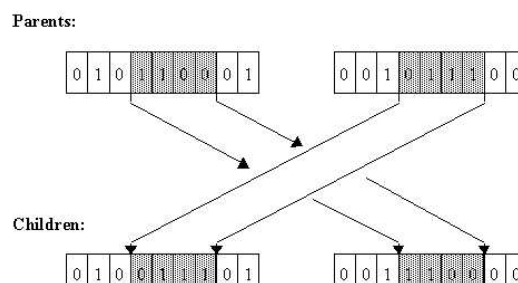
One complete round of the flow chart is called a generation and the result is called a candidate solution. This process repeats for many generations until the expected candidate solution is achieved. The candidate is considered acceptable by the fitness score it has got.



At the Selection step, candidates of a generation are selected by their fitness score. The selected members are then acted as parents of the next generation, which can be called survival of the fittest.

Armstrong, 2015

At the Crossover step (Mating), the selected parents are merged in pairs to produce new child candidates. There are many crossover or mating methods and the easiest way is to divide the string of each candidate into two parts. Then concatenate one part to another part of a different candidate, thus producing a new child candidate.



At the Mutation step, one of the bits of the child candidate's string is changed by a very small chance. This is to avoid local minimum of the AI model.

Courtenay, 2015

Fitness score is calculated and used to measure the error value of the candidates. The best candidate ideally has a very close to zero or zero score of fitness.

## **CHAPTER III**

### **RESEARCH METHODOLOGY**

#### **3.1 The Source and Sample Size**

Qualitative research with semi-structured interview is suitable for the data collection for this thematic paper because the needed information is best described and explained in a comprehensive and in-depth manner, which is difficult to retrieve by quantitative research methods. Thus, during the interview, there can be unprepared queries that arise from explanations of the interviewees. That is due to the complexity of the concepts and algorithms in the creation of self-coding AI. Moreover, business impacts can be very detailed and diverse because they involve different companies and people who are part of the economy.

The sources of information are from literature research or white papers about self-modifying AI, experts in Computer Science field and experienced business people. The literature research and white papers in the topic of AI will provide contemporary concepts, algorithms and guides to make self-modifying AI. Experts whose works or studies involve AI will also provide insights and understanding of how to make a self-modifying AI and also constraints they have experienced. Experienced business people who are familiar with the swing of economy and business impact factors or people whose works involve AI can also be included.

The sample size can be divided into two groups of self-coding AI and business impacts. Each of the group can have three to five interviewees. For self-coding AI group, experts in the field of Computer Science can be professors, researchers or data scientists. For Business Impact group, experienced business people can be business owners that employ at least 20 people or managers of small to large companies. In total, there can be five to ten interviewees.



### 3.2 Instrument

The research interviews will start with acknowledgement and collect signatures of the interviewees regarding the permission letter for the interview, or the interview consent form, provided by College of Management Mahidol University (CMMU). The interviews will be recorded electronically for the purpose of education and the interviewees shall be informed prior to interview sessions about the recording. The opening topic is a brief description of the purpose of the interview and then a self-declaration of the interviewer. The interviews should not put pressure on the interviewees and that will lead to an open-minded and informative discussion. The starting queries are about the interviewee's background of work or study, experience in the field, and reason of interest concerning their fields of expertise. However, the lack of experts in both groups influences interviewees to share their opinions in both ML and business aspects.

For Self-Modifying AI group, the main queries pinpoint to the technical knowledge of concepts and algorithms used to construct AI that can write or modify codes by itself. This part can include tools, such as programming languages, computer hardware and training set of data. The results or expected outcomes from implementing the concepts are also part of the explanations. More detailed probing queries are used to understand more about the explanations. For example, how to find the right parameters for the hypothesis function so that it is not overfitting or underfitting with the training set of output of the AI. Or what are the inputs and how to manage inputs, for self-modifying AI so that it knows how to write codes. Moreover, examples can also be requested for better comprehension.

For Business Impact group, the main queries focus on the relationship of components being regulated to run businesses and business ecosystem in the present day. Then, the ripple effects or the most hard hit components, businesses or sectors after the application of self-coding AI becomes feasible and valid. Potential consequences, decisions and regulations that they will have to be introduced to adapt to the change.

After the interviews, the interview discussions will be transcribed for analysis. All the information derived from the self-coding AI group will be summarized and constructed in a comprehensive manner for the reader of this thematic paper. This can be done by recognizing patterns or general ideas of different procedures that different interviewees provided. Details will also put into the right places to complete the process of making a self-modifying AI. Business Impact group's information will be summarized by emphasizing the most targeted business or sectors and the reasons with consequences of the impact.

Questions are divided into three main areas. The first area is about the work of the interviewees. The second area is about self-coding AI. The third area is about business impacts.

#### Questions Set

1. Machine Learning Application
  - a. What is the machine learning algorithm that you work with the most?
  - a. What type of problems you are solving with the algorithms from the answer of a?
  - b. How to get suitable data sets? How big is the data set? How do you manage it?
  - c. What is the hardest part?
2. Self-Modifying AI
  - a. What are the main concepts and algorithms used to make a self-coding AI?
  - b. How are the concepts and algorithms applied?
3. Business Impact on particular sectors
  - a. What business sectors should have the most impact from self-modifying AI?
  - b. How will self-modifying AI impact and change how people do businesses or works in Thailand? The consequences of self-coding AI?

## **CHAPTER IV**

### **RESEARCH FINDINGS**

The research findings are based on interviews which are conducted through face-to-face, telephone or via internet. All the interviewees work in the field of Machine Learning as lecturers, business owners, employees, and managers of companies. Consequently, much or less, they have knowledge about Machine Learning, self-modifying AI and business. All the interviewees do not intend to reveal their names but allow only some of their profiles disclosed.

#### **Interviewee 1**

A machine learning engineer who worked as a lab assistant for Concepts of Computing with Data, a data scientist at Bangkok Bank PCL, a data scientist at Bank of Ayudhya and currently a machine learning engineer at Data Wow. He graduated from University of California, Berkeley with double degrees of Statistics and Computer Science in AI and Machine Learning. He created AI models to help solve business problems such as labor cost reduction. He also was an invited as a guest speaker at Chulalongkorn University in the topic of AI.

He is currently working on an image processing project that uses a Convolutional Neural Network. The goal is to categorize pictures with the result of more than 98 percent accuracy because human can do the task with 95 percent to 98 percent accuracy. The project will help reduce labor costs of almost a hundred people. He has a big dataset of pictures, about 100,000 ones, and then he divided them into three main groups, 10 percent for data validation, 10percent for data testing and 80 percent for data training. He used the 80% data training to fine tune his AI model until he got the desired outcome, more than 98 percent accuracy. The problem of having bad quality of the data is that the model can become overfitted and that results in inaccurate performance when

the model is used. Bad quality of data can be from limited number of data and duplicated observations. If he runs out of data, in this case, pictures, he will find some more from the internet using scripts to help with the time and speed of the task.

The hardest part of making an AI model is fine tuning. The whole process is first, finding the right algorithm for the problem. Nowadays, neural network is the most popular algorithm that can solve many problems effectively. Then defining the variables, weights and features, for the model. Next, creating relationships between nodes. For his image processing project, there are more than 20 nodes in each layer and there are more than a hundred layers. The relationships of nodes can go across different layers, which depends on the creator who well understands statistics. Then, run the model with the data, the 80 percent data training group. In this process the training data is also divided into subgroups for the tuning. He runs the model with the data and compares the result with the real result. This process of fine tuning can be the most complicated part because the relationships between nodes can be complex with huge numbers of nodes and layers. This process goes in circle until it produces the accepted result. Running the model with the data can take days depending on the hardware. His advice is to use a high-end graphics processing unit (GPU), as that can reduce the time it takes by about 30 folds.

Talking about self-modifying AI, or AI that can write codes, now AI can create a set of codes by, first, use already made codes and, second, write codes by itself. The first one is AI that can use codes or functions of codes that were previously created. The other one is the AI that learns how to code from scratch. The latter one is a lot more difficult. For AI that can use ready-made codes, what happens is that the AI knows what pieces of codes do and it searches for the right one from a database of codes. Then it inserts it into a set of codes in order to fix or create a new one. Currently, it is also possible to create a compiled language that can do self-coding with the same original language but it is still very difficult. In more detail, the original program does not have to be terminated when the codes are updated or modified. Instead, the updated or

modified codes can be made into a library and executed within the original program. One of the techniques is Program Synthesis.

For AI that can write or modify codes, this type of AI is a lot more difficult to make. All the programming languages are created for humans, which is very hard for computers to learn. What it can do is that it learns how to write code from scratch by understanding a programming language and then writing codes. Recently, there are many researchers working on the topic and one possible algorithm is the Genetic algorithm. It still makes a simple program to print out words, such as “Hello”, “Good Morning”, and etc. what it does is that it randomly generates different strings of words and cut half of the strings and concatenate the first half of the first string with the second half of the second string and vice versa. Then it calculates the error of the result relative to the target words. It repeats the process until it gets the desired word. It also changes letters and repeats the process in case that the combination does not produce the desired result. The programming language that the program uses is still a simple one.

Now, when we have AI that can write codes and we need to create a self-coding AI, an AI that can write codes, we need more than one AI to work together. The first AI does what it is made for, such as playing a PC game. Then the second AI evaluates the result of the first AI and calculates the error, then edits the code of the first AI.

In his opinion, it will take quite some time, may be 10 years, for self-coding AIs to be in full operation and the job that will be affected is absolutely programmers. During that time, in his opinion, all others jobs, such as investment banking, accountants, graphic designers, musicians, would have been replaced or enhanced by AIs. Therefore, the big impact will fall upon people who can only write codes. Data scientists and Machine Learning engineers may still have time for the employment.



## **Interviewee 2**

A software engineer and lecturer at Progress Software Co.,Ltd at K-Bank and Acting Director at Center of Information Technology Services at Mae Fah Luang University, respectively. He graduated from Hochschule Furtwangen University. He has 12 years of work experience in software engineering and 4 years of experience in machine learning.

He is a software engineer who turned to machine learning and is experimenting with self-adaptive software using machine learning algorithms. Now he is developing a software to measure health of patients for a hospital using deep neural networks. The inputs are diagnostic results combined with general information of patients. Another of his projects is also implemented by using convolutional neural networks to gauge calories from pictures of food.

It is possible to write a software that can edit some parts of its own codes without the help from machine learning but it requires many more lines of codes. This software is semi-automate in terms of the ability to generate codes by itself. In other words, it cannot create another software by itself alone, instead it has function to help programmers write codes faster and those advanced functions need to be pre-constructed. He thinks that AI that can create a program or another AI may use the same concept. It has to be one AI that is capable of writing codes and it is equipped with algorithms, such as deep reinforcement learning. The AI will train its program and be able to pick more suitable sets of lines of codes or functions after rounds of training. It has to be deep reinforcement learning because the algorithm is capable of learning by itself, so we, humans, only give it inputs and criteria that shape the result programs.

In his opinion, the self-coding AI will transform Thailand's IT industry, especially in the area of application developers. In the future, we still need system integrators whose job are about hardware and software setup. System administrators are still required to take care of the systems. However, role of developers will change because some applications will be created by software that uses machine learning. AI

will be able to create more complex applications, which are currently done by developers. Some jobs in IT industry will gradually fade away but some jobs will still be required. In another aspect, many countries will be facing demographic time bomb and they will lack human resources, so it could be a suitable match for the decreasing human resources and increasing smart machines. After that, more companies will use AI to help with their businesses and it will be the creativity and strategy that set apart leading companies from the rest.

### **Interviewee 3**

He graduated from King Mongkut's Institute of Technology Ladkrabang in Computer Engineering. He used to be a web master for 3 years and now works at an international company being responsible for machine learning testing.

He is currently working on a project about natural language processing with Thai language. The goal of the project is to translate Thai speaking into Thai texts in order to solve a problem of a customer whose job involves telephone communication with customers. What he does is training the algorithm to produce the expected outcome of the translation. He suggested the concept of making an AI that can generate programs or write another artificial intelligence is to use deep reinforcement learning. It needs to have an AI model that is instructed to build another simpler AI. Then the created AI or child AI is tested and the result is sent back to the creator AI for the next improvement until the child AI reaches the desired result.

In his opinion, the self-coding AI will be in the hands of very big companies. To imagine that when AI that can create another AI or a program really exist and are put into use, there could be a less demand of data scientists because creating an AI model is currently done by data scientists. It takes a lot of time and effort to build an AI model or a program to tackle with complicated problem, so self-coding AI would definitely accommodate the process. Moreover, new startups could also create an AI-creating AI because there are so many machine learning libraries and they are open-source, such as TensorFlow, Apache Mahout, Apache Sparc, H2O and etc. There are many huge



communities that are doing research in the topic. However, he is quite confident that businesses will require more machine learning engineers when IA-creating AIs are commercially and widely used because they will be the ones who have to work with the AI. The process of making a program or an AI by AIs still requires human's interaction. For example, data set for AI training is still prepared by machine learning engineers. The result must be tested and if it is not satisfied, the machine learning engineers will have to do some adjustments with the data and process. Not only would the need for machine learning engineers increase but also the demand of application developers who specialize in particular skills or even full-stack developers. For example, AIs have to interface or work with devices or other applications and the task of connecting them will be done by developers. In other words, human developers are the people who have to put self-coding AI into use.

#### **Interviewee 4**

He holds a Ph.D. degree in Physics from California Institute of Technology. He founded a software company, named Atrium Technology. Currently, he established a school of science, Pratomtam, and is a lecturer at Mahidol University. He was a speaker at TEDxBangkok.

There are many algorithms for implementing AI, such as Linear Regression, Decision Tree, Classification (Logistic Regression), and etc. Among them, Neural Network is the most popular one right now. Neural Network algorithm need to have relationship between nodes within/outside the layers. That makes the algorithm able to think and solve problems. For self-coding AI or AI that can write a program or another AI, the closest one is the AutoML of google. They made an AI that can code another AI by using pre-defined algorithms and refining the ones that are previously chosen. AutoML tries and tests different algorithms to find the most suitable ones for the problem and then improve them further, which takes less time and effort than the same work done by machine learning experts. The final architecture that AutoML creates can

have different elements of algorithms combining together. Talking about time and effort required to make an AI model, typically a deep learning one, a 10-layer network can have about 10 to the power of 10 versions and that could take years for teams of top-in-the-field researchers and engineers to calibrate. That is almost impossible for someone like us. AutoML will help automate the AI model design and creation.

One of the algorithms AutoML is using is reinforcement learning algorithm. The concept that having an AI, called the controller, builds an AI, called a child AI model, uses reinforcement learning with recurrent neural network (RNN) at the controller node. Then it uses predefined machine learning models to build a child model. The child model will be tested for so many thousand times so that it has the optimal result. Each round during the test, the controller receives feedback and improves the architecture of the child AI model. The architecture of the child AI model is comparable to the one that is created by top machine learning experts.

Talk about effects of the self-coding AI towards businesses, there will be machine learning services available for people who neither have much knowledge about machine learning and money to hire machine learning experts. This resembles how we created websites in the past and later, we had Dreamweaver helped making ones by just dragging and dropping. Even today, we can create a website from various web creating websites without knowledge of coding. Perhaps, software developers will be the jobs that are affected when programs can literally create programs. For one thing, the role of developers will change because it will be easier to create a program to tackle business problems. The machine learning related automation will be ubiquitous and developers will have to learn more about Internet of Things (IOT) that is about information that we can receive from various devices. In other words, developers will need more than coding skills. Some developers will have to turn themselves into machine learning engineers. Moreover, today's complicated software will be available to more people in the future, so small-to-medium and medium-to-large companies will get more access to the software

and they will need more employees who can deal with the technology thus, increasing the demand of IT people in the field.

In addition, education will gradually change due to the fact that more people will get access to the internet and there will be applications that support students in learning. Machine learning also can be applied to help students learn faster and easier. Perhaps, less teachers would be needed. But he thinks that we still need human teachers for young, adolescent and high education students, such as Master and Doctoral degrees and the role of teachers may also change.

#### **Interviewee 5**

A PhD student working on a project of dental practice software for new dental graduates. The name of the software is intelligent tutorial system. The software focuses on teaching decision making skills on dental surgery only on root canal treatment for dental students with real-time simulation of surgery.

The interviewee 5 initially suggested her interests in different field of study rather than machine learning so we skipped to the business impact questions.

The interviewee thought that AI that can create programs and AI will have a great impact to IT jobs because that is exactly the jobs of most IT developers who specialize in coding. In the future, AI will get better at coding and even to the level of improving their algorithms. When the time comes, it may not just developers but also data scientists who will have to adapt.

## **CHAPTER V**

### **CONCLUSIONS**

#### **5.1 Conclusion**

Artificial Intelligence (AI) plays an important role in transforming economies around the world and it will have great impact upon people when it reaches to the level of close-to-zero assistance from humans in the creation of it. Therefore, this research is intended to explore the possible concepts and algorithms of developing exist the Artificial Intelligence that can write and modify codes which results in a new program or even if an AI itself. Moreover, the impact of this type of AI to Thailand's particular business sector will also be inquired to find out the possible consequences.

##### **5.1.1 The make of self-coding AIs**

From the research and interviews, it is very difficult to create a program that understands and is able to use existing programming languages, widely used by application developers, to write codes in a way that is similar to what humans do. This is because the programming languages were created by humans to be comprehensible only for humans. Additionally, the way machines and computers perceive inputs or information is different from how humans do. Therefore, it would be more difficult to teach AI to understand how to code than to let the AI learn how to code by itself. From this approach, reinforcement learning is likely more preferable to supervised and unsupervised learning ones. The reason is that supervised and unsupervised learning algorithms are best suitable for problems that, first, we have correct and clear inputs and outputs so that we can teach the AI to learn by matching and predicting the results. Second, factors, also known as features in this case, involved in the thinking process of supervised and unsupervised learning are not that complicated. Whether the factors are too complicated or not depends on the number and relationship of the factors. Actually

a complex problem can be solved by supervised learning algorithms but the performance, accuracy and time required for training can be much more. Therefore, reinforcement learning with neural networks is unavoidably chosen to create AI that can create a program or AI. One drawback of this approach could be the fact that we may not know how the AI come up with the answer or result but we can utilize it.

As far as this research has gone, there are two possible approaches in making a program, or AI, that can create codes or AI. The first approach is to use Genetic algorithm to create a program that can write codes from scratch and the second approach is to use deep reinforcement learning algorithm to do so.

Genetic algorithm mimics the way evolution works, so what it does can be perceived as mutation from randomization. It tries different words, mixes them together, changes a letter and mixes them again. Currently, the program can only create a program that produces strings of words using a simple programming language.

Deep reinforcement learning algorithm that is used to create AI that can write an AI model consisting of a couple of algorithms, which are neural networks, deep neural networks and recurrent neural networks. The underlying algorithms that deep reinforcement learning uses are neural networks, which is similar to how animal's brains work. An animal's brain can have billions of neurons with complex relationships. Neural network also has neurons, can also be called nodes, and their relationships. This neural network allows the AI to learn from given inputs by itself. The direction or goal of the output is controlled by reward and punishment set by humans. Deep reinforcement learning is a scaled up reinforcement learning. It has a lot more nodes and layers in the hidden layer, thus making the relationship more complex. Recurrent neural network is an algorithm that enables neural network to have memory. The effect of having recurrent neural network is that the AI can calculate current actions by taking into account multiple results of different other current, previous and future actions. An analogy of this behavior is when we want to swim in a lake because we are on vacation. The weather is hot and before we get into the water, we may automatically think of dangerous animals that could live in the lake from our past experience or any warning sign. We also guess



the depth of the lake and our ability to swim together with the current stamina. Will it rain and is it going to be cold are also questions that we have in mind. The thinking process combines current conditions and also past and future information.

This AI-creating AI still cannot really write code from scratch. It needs pre-defined algorithms and AI models created by humans. It picks and try different ways to create a child AI model that has the best result. In order to get the best result, it trains the child AI model with the given data set and use the feedback to improve the child AI model. According to the interview 4, the result of the child AI model is quite impressive.

Therefore, two possible concepts of making AI that can write codes or create AI models by itself are, first, genetic algorithms which uses mutation and randomization concept and second, deep reinforcement learning with recurrent neural network which choose and tweak pre-defined AI models to create, train and improve child AI models.

### **5.1.2 Business Impact**

Self-coding AI is in progress of improvement. In interviewee 1's opinion, it could take ten years or sooner until the AI will be put into real application. The question is what particular business sectors or jobs the impact will fall upon. From the analysis, it can be concluded that jobs in the IT field will have a direct impact. Before going to the types of impacted IT-related jobs, there are many roles of IT-related jobs, such as developers, system integrators for both hardware and software, system administrators, IT technical consultants, and etc. Normally all of them are required to continually learn new skills due to the nature of technology that is always changing. However, one role will have to take a huge change and that is the developers. This is similar to heavy industrial machines replacing labors. The AI's ability is the same as of the developers but with more accuracy and speed. So as the AI learns to code with more programming languages, more developers will have to adapt and change their roles.

This does not exactly mean that developers will lose their jobs but they have to change from the coding task to controlling or inspecting the AI. They may have to

learn machine learning skills and how to use the AI to help with the businesses because more companies will have easier access to AI as mentioned by the interviewee 2 and 3 that AI would be provided as a service and it can be bought by any companies. As a consequence, developers have no choice but to adapt and in the long run, the demand for developers would decrease. However, the demand of people who have skills of machine learning and AI application will increase corresponding to the high AI adoption rate of businesses.

## **5.2 Recommendations**

Machine learning algorithms in the category of reinforcement learning are being developed for the creation of AI that can code programs and create AI models. The result shows slow progress because it could be more difficult to teach AI to understand and be able to create a program than let the AI learn by itself. Deep reinforcement learning with recurrent neural network shows solid promise of AI-creating AI. These algorithms, currently, could be the best choice for someone who is interested in doing research about self-coding AI.

In many years to come, application developers will still thrive until the market adopts self-coding AI. Roles and responsibilities of developers will change. Many of them will have to acquire machine learning and AI application skills due to the expected demand from the businesses.

## **5.3 Limitations and Suggestions to Future Research**

The limitation of this research is mainly the lack of data scientists and machine learning experts who purely work on the improvement of machine learning algorithms in Thailand. Therefore, the analysis of this research could not go deeper in terms of technical aspects.



Moreover, there are still less companies who apply AI, especially companies in IT industry. Consequently, analysis of business impact by self-coding AI can still be further developed.

In my opinion, it is likely that in the future, there will be a breakthrough in hardware technology that makes it possible for machine learning to leverage more of the hardware performance. Many countries and large companies also invested a lot in machine learning, which speeds up the research in machine learning algorithms. Therefore, we would come closer to the application of AI that can write codes with any programming languages with new concepts and algorithms or there could be a research focusing on AI that can help data scientists decipher new algorithms to better solve problems. Moreover, practically, Thai businesses will have to respond and utilize the technology and deal with the effects. During that time, we would see more Thai companies applying AI and more data scientists in Thailand. Data collection for research would be easier, thus producing better and more accurate analysis and result

Accordingly, more insights and concepts of self-coding AI and more detailed impact on business sectors can still be further explored.

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## **Interview Scripts**

### **Interviewee 1**

#### **Background Work**

He studied machine learning in his Bachelor's degree and has been working in the field of machine learning since then. He currently works at a startup company providing machine learning service. The project he is doing is about image processing and he uses convolutional neural network as the algorithm. Then he explained about the process of making an AI model, which is his current project. The most difficult parts are algorithm fine tuning and data preparation.

#### **Self-coding AI**

In his opinion, there are two types of AIs that write codes. The first one is AIs that use ready-made codes and the second one is AIs that learn to write code from scratch.

The first type of AIs needs to have two AIs. One of them improve the other one by training it with data set and get feedback for improvement. The second type of AIs uses genetic algorithms to create lines of code.

#### **Business Impact**

The jobs that will be affected by AIs that can write code are application developers because Ai will be able to do the task with more accuracy and speed. Data scientists and machine learning engineers will still be needed.

### **Interviewee 2**

#### **Background Work**

Most of my projects were about software engineering and software architecture. Later I work on a project about AI for the purpose of having cheaper cost of AI implementation because nowadays, we need experts to build an AI and the cost is



high. One project is self-adaptive software. How to build a software that can adjust its functions to match with the surrounding contexts, which is users' needs. Machine learning algorithms are also part of the software. Another project I implemented for a hospital is a software to help patients know about their healthy by using the patients' information. The project used neural networks as the algorithms. First, an illness must be picked so that we knew what type of input I would need and then we collected diagnostic results and also general information, such blood type, blood pressure, age, sex, weight, height and etc. to be included as inputs. This could give us more clues about the patients' health. Another project is image recognition. We measured calories of food from its' pictures. We used convolutional neural networks for this type of problems. Different types of algorithms suit different types of problems. Moreover, TensorFlow of google is an open source for machine learning library that we can practice and use machine learning algorithms. We can run our inputs on the platform and wait for the result without knowing much about machine learning. Personally, I haven't really done a project of AIs that can code or create another AI. There are researchers in the field and I know a brief concept. As far as I know, this research will be focusing much on the algorithm itself but it is hard to find one in Thailand because most of the people I know are doing projects that only utilize the algorithms created by foreign data scientists.

### Self-coding AI

Nowadays, we can create software that can fix its own codes without machine learning algorithms but much work has to be done in preparation for the software. It can only fix parts that we predefined and it requires lots of coding. If we want to have to more complete self-fixing software, we would have to spend more time and effort in the preparation.

Talking about the project that I did for the hospital. I used neural networks and had to prepare data by categorizing it as different features. Then we ran it in the neural networks to see how many layers and nodes we needed. There is a formula, called

pruning, to help determine the number of nodes. Inputs and outputs are fixed because number of inputs equals to the number of features and the number of output is the answer we need.

It took about two to four days to train the data of one hundred thousand records. Then we inspect the accuracy of the model and adjust the number of layer to give more accuracy. The hardest part is the tuning and data preparation. If the data is bad, the result will be bad too.

TensorFlow doesn't need a database but it uses .csv file instead. Then I used a service of google called AutoML that provides ready-made web application that can be used on mobile phone.

#### Business Impact.

The impact really depends on the application. It will take a lot of time until we have the self-coding AIs. Because self-driving cars are still in experimental phase even though we heard a lot about how advanced they are. They have to pass serious security test and trust before they are put into use for real. For now, they are not that mature.

Application developers who do not have advanced knowledge will have to adapt and learn more skills because it will be a lot easier to use software by business people. But IT people in some fields are could be still doing fine, such hardware and software setup engineers. Companies will still need them. A lot of countries are facing with more old people than young ones, so AI could suit the situation well. In the future, we, human will have to rely much on our creativity and social skill to compete in the market.

Government might take action but I don't think that it will matter much because this is like a technology and business trend that naturally go by themselves. Some policies might be issued, for example, tax for AI. This was also mentioned by Bill Gates.

### **Interviewee 3**

#### **Background Work**

His current project is about language translation by computer using natural language processing to interpret voice into letters. His role is to train and evaluate the result of the program and the expected result is above 95% accuracy.

#### **Self-coding AIs**

Deep reinforcement learning is the suggested algorithm. And the concept is to use an AI with deep reinforcement learning to build another AI that is less complicated than the AI-generating AI. Then a data set will be used to test and the test result will be sent to the creator AI to optimize the created AI. The process of optimization will be done in loop for thousands of times.

#### **Business Impact**

The AIs that can code and build another AI could drop the demand of data scientists but increase the demand of machine learning engineers and developers in particular areas.

### **Interviewee 4**

#### **Self-coding AI**

There are a lot of algorithms that are used to create AIs, such as linear regression, decision tree, classification or logistic regression. Deep reinforcement learning or we often hear it as neural networks is the most popular for now. It works by providing a lot of data to the algorithm to learn from scratch. Then the algorithm will find patterns from the data. The application really depends on the data that we put into it.

One AI that can create AIs is the AutoML of Google. This is the closest one to the ideal self-coding AIs. They made an AI that can code another AI by using pre-defined algorithms and refining the ones that are chosen. AutoML tries different algorithms and test them to find the most suitable one for the problem and then improve

it further, which takes less time and effort than the work done by machine learning experts and machine learning engineers. The final architecture that AutoML creates can have different elements of algorithms combined together. Talking about time and effort required to make an AI model, typically a deep learning one, a 10-layer network can have about 10 to the power of 10 networks and that could take years for teams of top-in-the-field researchers and engineers to make one. Therefore, it is almost impossible for someone like us. Therefore, AutoML will help automate the design.

There could be some algorithms that Google use to develop AutoML and reinforcement learning is one of the main algorithms. The concept is that Google has a controller AI whose job is to build and improve AI models. The AI models that are built and improved by the controller AI are called child AI models. The controller AI cannot really do the coding like we do yet, so it builds child AIs by using created lines of code and pre defined algorithms like libraries and functions that we use in programming. The child AI will be tested and modified by the controller AI until it produces the expected result. Then the team of Google's data scientists will inspect and compare with their AI model for further improvement of the controller AI.

Google reinforcement learning has recurrent neural network. It can give the ability of memory to the program. Normally, each neuron in neural networks will calculate only one input, but recurrent neural network makes the neuron calculate more than one input. So it is like the neuron thinks what action it will do by taking into account of some other actions. This is similar to how we, humans, or animals think. When we decide to do something, we think about our past experience that is related to the action we are about to do.

### Business Impact

I think we will have easy access to using AIs and that is what Google is trying to do with the AutoML. If you still remember, 15 years ago, we built website using a few programming languages and we had to write almost every single line of code. But later, there were software that helped us create websites. We did not have to type

the syntaxes and create every variable Dreamweaver is one of the programs. Nowadays, we just drag and drop and we get a website, which requires weeks to make in the past. From the change, programmers seem to have less importance because you do not have to know how to code but you can have a website that collects sale transactions, does online payment and bills customers. This does not mean companies do not need programmers because as the companies growing, there are more tasks to do, so companies still need someone who can take care of the websites and IT system and people in IT field have knowledge to perform the task better.

Therefore, I think that the role of developers will change and the importance of the job will be hindered. In the future, data collection, such as internet of thing will be another field that creates jobs, so there will also be vacancies and people have to learn new skills.

Education is also an area that will be affected by the technology especially AIs and increase in internet access. Students can learn things that they are interested in without much help of teachers because they can find the sources on the internet and there will be many learning support systems available in the future like Multi Online Open Courses (MOOC). So role of teachers will also change. I do believe that we still need human teachers for kids and teenagers and also research of high education.

#### **Interviewee 5**

##### **Background work**

First, I have to tell you that I do not have much of deep knowledge about AIs and machine learning algorithms but from business point of view, I can help you.

The project I am doing is intelligent tutorial system that teaches dental student about decision making skills in surgery room. The difference between the software and ordinary teaching systems is that it gives feedback to students, which is similar to teachers giving feedback to students. Therefore, the goal is to make this software interactive and adjustable as if the real dental instructors would do with dental students. From what I have observed in the surgery room, I noticed that all the operation



performed by dental students are based on surgical procedures. I cannot find enough information about dental surgical procedures in surgery room, so I had to pick knowledge representation which is Planning Domain Definition Language (PDDL). PDDL is knowledge presentation that can show causes and effects of actions. This is to create thinking system for computer. What I have to do was that I went to operation room and extracted all actions dental students performed and suggestions and feedback from dental instructors. This is how it works, while dental students are performing their operations, they system will simulate the on-going operation in a monitor. So the system will give feedback to the students in real-time. The students need to attach a device to their hands so that the system has inputs and can make the simulation related to the real operations.

Skip to business impact question

#### Business Impact

Self-coding Ai, in my opinion, will have great impact on all business sectors for both positive and negative sides. That really depends on the intention of users. The sector that will be affected the most is IT sector because if there are AIs that can create codes and also AIs, then many of the IT jobs will be replaced, such as programmers and system administrators. However, some IT jobs may still be needed, such as hardware integrator and high level of data scientists. Moreover, to look further into the future, majority of IT job could be replaced because AIs could outsmart humans in many more ways and even improve themselves without the needs from data scientists.

## INTERVIEW CONSENT FORM

**Letter of Informed Consent**

Date.....17.....November.....2017....

Title of project: Self-Coding AI and Business Impact

Name of researcher: Mr. Pakorn Suthigraert

Name of supervisor: Professor Roy Kouwenberg

Contact information of the researcher: Phone: 087 915 7733 E-mail: zwokap@gmail.com

Dear Sir or Madam,

You are invited to participate in the above research project, initiated at the College of Management, Mahidol University.

The objectives of this research are: To find out and understand underlying concepts and algorithms in the creation of AIs that can code a program or another AI. Moreover, impacts that the AIs would generate for particular business sectors

To achieve these stated objectives, I would like to request your help in (check):

Filling out a survey form

Participating in an interview

Other (specify) \_\_\_\_\_

The risks involved in participating in this research include:

Details: \_\_\_\_\_

None

In the research report, your identity (name and contact) will be (check):

Kept confidential

Revealed

Explanation (if necessary): \_\_\_\_\_

**Please be aware of your rights to:**

- Decline to answer any questions you do not feel comfortable answering
- End your participating at any time

Thank you very much!

I have carefully read and fully understand the information above.

Signature Nacha Chondamrongkul (Research participant)

( Nacha Chondamrongkul )

Date 20 / 12 / 2017

**Letter of Informed Consent**

Date.....23...../.....November...../.....2017....

Title of project: Self-Coding AI and Business Impact

Name of researcher: Mr. Pongkorn Saipetch

Name of supervisor: Professor Roy Kouwenberg

Contact information of the researcher: Phone: 087 915 7733 E-mail: zurokap@gmail.com

Dear Sir or Madam,

You are invited to participate in the above research project, initiated at the College of Management, Mahidol University.

The objectives of this research are: To find out and understand underlying concepts and algorithms in the creation of AIs that can code a program or another AI. Moreover, impacts that the AIs would generate for particular business sectors.

To achieve these stated objectives, I would like to request your help in (check):

- Filling out a survey form  
 Participating in an interview  
 Other (specify) \_\_\_\_\_

The risks involved in participating in this research include:

- Details: \_\_\_\_\_  
 None

In the research report, your identity (name and contact) will be (check):

- Kept confidential  
 Revealed

Explanation (if necessary): \_\_\_\_\_

Please be aware of your rights to:

- Decline to answer any questions you do not feel comfortable answering
- End your participating at any time

Thank you very much!

I have carefully read and fully understand the information above.

Signature  (Research participant)

(.....Pongkorn Saipetch.....)

Date.....20...../.....12...../.....2017....

## Letter of Informed Consent

Date: 6 / 1 / December / 2017

Title of project: Self-Coding AI and Business Impact  
 Name of researcher: Mr. Pakorn Sathiprasert  
 Name of supervisor: Professor Ray S. Sawyers  
 Contact information of the researcher: Phone: 087 515 7733 E-mail: zurakup@gmail.com

Dear Sir or Madam,

You are invited to participate in the above research project, initiated at the College of Management, Mahidol University.

The objectives of this research are: To find out and understand underlying concepts and algorithms in the creation of AIs that can make a judgment or another AI. Moreover, impacts that the AIs would generate for particular business sectors

To achieve these stated objectives, I would like to request your help in (check):

- Filling out a survey form  
 Participating in an interview  
 Other (specify) \_\_\_\_\_

The risks involved in participating in this research include:

- Details \_\_\_\_\_  
 None

In the research report, your identity (name and contact) will be (check):

- Kept confidential  
 Revealed

Explanation (if necessary): \_\_\_\_\_

Please be aware of your rights to:

- Decline to answer any questions you do not feel comfortable answering
- End your participating at any time

Thank you very much!

I have carefully read and fully understand the information above.

Signature: *M. S.* (Research participant)

Nantana Vannaprasit

Date: \_\_\_\_\_

