Intelligent Technology (iTech) for the 2020 Fall *Evening MBA in Intelligent Technology Management*

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'I can only teach what I know and I can only demonstrate what I can do', JS.

Contents

1 Introduction

Today, intelligent technology has been applied in almost every corner in the world. Every time a photo of friends has been uploaded to Facebook, Facebook will automatically square the faces and give name suggestions. The face recognition technology is an intelligent technology. While a LINE message is edited, the iPhone will automatically give next-word suggestions (predictive text). The technology behind this is an intelligent technology. A car can now drive from one place to another without human intervention. Clearly, auto-driving is yet another intelligent technology.

There are huge number of applications that have applied intelligent technologies. Sometimes, we have even been unaware of being beneficial by intelligent technologies. For instance, news feed and friends recommendation in Facebook are developed based on intelligent technology. Some network security systems have applied intelligent technology for intrusion detection.

1.1 What is Intelligent Technology (iTech) ?

Intelligent technology (or intelligent technologies), it usually refers to (I) *a collection of technologies whose algorithm*[1] *designs are inspired by or copied from the ways how human thinks and the methods how a human being solves problems*; or (II) *a collection of technologies for solving problems used to be solved by human beings*.

1.1.1 Type (I) Intelligent Technology

The technology applied in the fuzzy logic-based auto-parking system is an example of the first type. Fuzzy logic is theory extended from the classical logic to tackle actions involving linguistic variables like 'turn more left', 'turn more right', 'low speed' and 'high speed'. The technology applied in the optical character recognition (OCR) system is another example of the first type. Specifically, this technology being used in the 1990s and 2000s was neural network, in which the model is inspired by the neuronal network in human brain. Nowadays, the technology being used is deep neural network (equivalently, deep learning model).

For the first type of intelligent technologies, the technologies developed must have certain intelligent essence. The problems to be solved could be combinatorial optimization problems, financial prediction problems and system control problems. These problems could be solved by methods other than intelligent technologies. Intelligent technology is just an alternative method.

[1] An algorithm is essentially a step-by-step procedure (i.e. a program), an operations procedure, a process or a method for solving a problem. So, an algorithm design could be interpreted as a program design, an operations design, a procedural design or a methodology design.

1.1.2 Type (II) Intelligent Technology

Driving a car is task to be done by a human driver. Today, many car manufacturers have equipped a car with an auto-driving system. Auto-driving system is a complicated system which applies various intelligent (and non-intelligent) technologies for object recognition, speed control, road event prediction and others. These intelligent technologies are examples of the second type. Google AlphaGO is a system designed to play GO game. To win a game, it is a problem to be solved by a human player. Thus, the technology behind AlphaGO is another example of the second type. Google translator applies an algorithm called Long-Short-Term-Memory (LSTM) model to learn to translate a sentence from one language to another. The LSTM is an intelligent technology of this type.

For the second type of intelligent technologies, the technologies developed for solving the problems used to be solved by human beings could have no intelligence nature. For example, to recognize an object in an image, the object has to be segmented in the first place. The object segmentation algorithm is basically an image processing algorithm which is not intelligent at all. That is to say, the technology developed for solving a problem used to be solved by an intelligent human could be non-intelligent.

1.2 Other References for Intelligent Technology

Apart from the above references, intelligent technology could be referred to (equivalently, interpreted as and perceived as) a *product* like Sony AiBo, a *service* like Amazon ECHO, a collection of technologies like neural machine translation and deep neural networks, a machine learning algorithm. The product and service are called the *intelligent product* and *intelligent service*.

Intelligent products and intelligent services could also be integrated and applied to develop other intelligent products and intelligent services. Moreover, the technologies developed in areas of *AI*, *machine learning* and *cognitive computing* are intelligent technologies.

1.3 Related Concepts

Today, concepts of intelligent technology have appeared in the areas like AI, machine learning, cognitive computing, computational intelligence, soft computing and many others. Clarification of related concepts is necessary.

1.3.1 Intelligence and Turing Test

Human intelligence (resp. *machine intelligence*) is referred to the capacity a human (resp. machine) in problem solving. *Artificial intelligence* is thus referred to the capacity an AI algorithm in solving a specific problem. While we have intelligence quotient (IQ) to measure the intelligence capacity of a human being, there is no such measure for AI or machine intelligence. Only a test proposed by Alan Turing could be used to examine if a machine has intelligence.

Suppose a machine and a human are placed in two rooms. A human tester then asks a question, by putting the question on two pieces of papers, to both of them. The machine (resp. human) responses to the question by putting the answer on a piece of paper. Finally, the human tester has to identify from their answers who is machine. If the human tester fails to identify, the machine is claimed to be intelligent.

By the Turing test, one can readily infer that Deep Blue, the machine defeated the world champion on chess game, and AlphaGo are not intelligent. It is because we can identify from the number of wins who is machine.

1.3.2 Learning Algorithm, Model and Cost Function

Normally, an intelligent technology (but not all intelligent technologies) associated with a *parametric model* (equivalently, an hypothetical model) which generates the observations (resp. samples). As the parameters of the true model are unknown, it is inevitable to develop *an algorithm to update the parameters of a model (i.e. learning algorithm)* such that the parameters of the true model can be found eventually.

Here is a simple example. Let say, we have a set of N samples $\mathcal{D} = \{\mathbf{x}_k, y_k\}_{k=1}^N$, where $\mathbf{x}_k \in R^n$ and $y_k \in R$ for $k = 1, \cdots, N$. Assuming that this data set is generated by a linear regressor, i.e.

$$y_k = a + \mathbf{b}^T \mathbf{x}_k + \xi_k, \tag{1}$$

where ξ_k is a random noise. As a and $\mathbf{b}$ are unknown, we define the following model to learn from the samples the true parameters.

$$f(\mathbf{x}_k, \hat{a}, \hat{\mathbf{b}}) = \hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_k. \tag{2}$$

Given $\hat{a}$, $\hat{\mathbf{b}}$ and $\mathcal{D}$, the mean square error (MSE) between the parametric model (2) and the true model (1) is given by

$$\begin{aligned} E(\hat{a}, \hat{\mathbf{b}}) &= \frac{1}{N} \sum_{k=1}^{N} \Big(y_k - f(\mathbf{x}_k, \hat{a}, \hat{\mathbf{b}}) \Big)^2 \\ &= \frac{1}{N} \sum_{k=1}^{N} \Big(y_k - \Big(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_k \Big) \Big)^2 . \end{aligned} \tag{3}$$

Taking derivative of (3) with respect to $\hat{a}$ and $\hat{\mathbf{b}}$, we get that

$$\frac{\partial E(\hat{a}, \hat{\mathbf{b}})}{\partial \hat{a}} = -\frac{2}{N} \sum_{k=1}^{N} \Big(y_k - \Big(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_k \Big) \Big) \tag{4}$$

$$\frac{\partial E(\hat{a}, \hat{\mathbf{b}})}{\partial \hat{\mathbf{b}}}, = -\frac{2}{N} \sum_{k=1}^{N} \Big(y_k - \Big(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_k \Big) \Big) \mathbf{x}_k. \tag{5}$$

Clearly, the true parameters could thus be estimated by setting the above equations to zeros. It works for N which is not large, say $N = 10^5$.

For large N, say $N = 10^{12}$, this method will not be feasible. An alternative approach is to design the search for true parameters by the following iterative equations.

$$\hat{a} \leftarrow \hat{a} + \mu \left(y_t - \left(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_t \right) \right) \tag{6}$$

$$\hat{\mathbf{b}} \leftarrow \hat{\mathbf{b}} + \mu \left(y_t - \left(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_t \right) \right) \mathbf{x}_t, \tag{7}$$

where μ is a small positive number called step size, $(\mathbf{x}_t, y_t)$ is a sample randomly picked from $\mathcal{D}$. The initial values of $\hat{a}$ and $\hat{\mathbf{b}}$ are small random numbers around zero. As a result, an algorithm to estimate the true parameters could be listed below.

S1 Initialize $\hat{a}$ and $\mathbf{b}$ to small random numbers around zero. Set $\mu = 0.01$.

S2 Repeat the following steps until the square error is smaller than 0.0001.

S2.1 Pick a sample randomly from $\mathcal{D}$ and set it to be $(\mathbf{x}_t, y_t)$.

S2.2 $\hat{a} \leftarrow \hat{a} + \mu \left(y_t - \left(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_t \right) \right)$.

S2.3 $\hat{\mathbf{b}} \leftarrow \hat{\mathbf{b}} + \mu \left(y_t - \left(\hat{a} + \hat{\mathbf{b}}^T \mathbf{x}_t \right) \right) \mathbf{x}_t$.

The above procedure is called the *learning algorithm* for the model (2) to learn from the data set $\mathcal{D}$ the behavior of the true model (1).

Thus, the *mathematical model*, the *cost function* to measure the fitness of the model and the *learning algorithm* are the essential components for an intelligent technology. To understand the working principle and the limitation of an intelligent technology, one would need to understand these three components. One note to add, the *cost function* is also called the *learning objective function*, *learning objective* or *objective function*. By showing its value after each round of learning, i.e. the steps S2.1, S2.2 and S2.3, one can check the progress of learning.

1.3.3 Learning Machines

The term *learning machine* has already appeared in 1959 in an article authored by Friedberg on specialized learning machine[2] and in 1965 by Nils J. Nilsson on a general introduction on the learning machines in that era[3]. In that period of time, a learning machine was referred to a digital computing machine like IBM 704 or a specialized designed machine like Perceptron Mark I that is able to implement a learning algorithm. Today, the term *learning machine* has rarely been linked to an intelligent technology or a hardware with intelligent technology inside.

[2] R. M. Friedberg, A Learning Machine: Part I, *IBM Journal*, pp. 2-13, January 1959.

[3] Nil J. Nilsson, *Learning machines: Foundations of trainable pattern-classifying systems*, McGraw-Hill, 1965.

1.3.4 Smart Home/City/Material

While the Chinese translation of the 'smart' in smart home, smart city and smart material is the same as the 'intelligent' in intelligent technology, one should not confuse that the actual meanings of both of them are very difference. Strictly speaking, smart homes, smart cities and smart materials are not intelligent, while intelligent technology could be applied in making part of a home (resp. city) smart. A smart home is normally referred to a home with fully automated control of the home appliances. For instance, the A/C could be set to be automatically on at 18:00 every day. All the lights in the living room will be off if the sensors sense no any conversation at home for more than 15 minutes. Amazon ECHO and Google HOME are two intelligent systems that can used for making a home smart. However, the services delivered by Amazon ECHO and Google HOME are a lot more than making a home smart.

Regarding smart material, the goal is even far different from intelligent. The ultimate goal of smart material is to synthesize new materials for special applications. The materials include the material for making lighter cloth for athletes and soldiers, the harder and stronger material for making fighting jets, the material coating on a fighting jet to make it invisible under any radar system. So, smart material is not an intelligent technology. It has nothing related to intelligence. One should be confused.

1.4 Intelligent Technology : What is It ?

So, what is intelligent technology? After all, an intelligent technology is a technology that is able *to solve the problems used to be solved by human beings*. This technology could have no any inspiration from human behaviors or biological neural structure. On the other hand, intelligent technology could be a technology its *model* is inspired by *human behaviors* or *biological neuronal structure*. It is a technology its *learning algorithm* is inspired by *human genetic evolution*. These intelligent technologies are applied to a wide range of problems including engineering problems, management problems and others. The relations amongst intelligent technologies, intelligent products/services and intelligent systems are shown in Figure 1. In the bottom level, there are (generic) intelligence technologies, including those models that you can find in AI/ML textbooks, and non-intelligent technologies, including computer technologies and communication technologies. These two types of technologies could thus be applied to develop intelligent products and services.

1.5 iService using both iTech and non-iTech

Let us have an example. iPhone is an intelligent system with two intelligent services FaceID and Siri. FaceID is a built-in security system to authenticate the user. It uses a face recognition software to capture the 3D face features of the user and use them as the key to unlock the iPhone. The face recognition software is developed based on intelligent technologies together with image processing

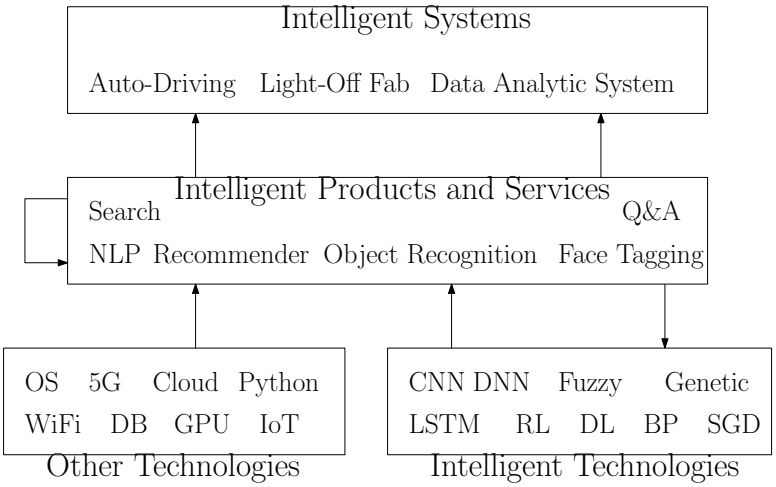

Figure 1: Intelligent technologies, intelligent products/services and intelligent systems.

technologies (non-intelligent technologies) for face recognition.

Siri is another built-in system for converting speech to text. Once the Siri is on, user could speak out a speech and then Siri will convert the speech to a text message. Imagine that your speech is a command like 'phone call Mary please'. It is clear that Siri can get this text message as well. If this message conforms to the format of a voice command and the name Mary is listed on the phone book, the voice command module in the iPhone will act on behalf of the user to make the phone call to Mary.

Figure 2 shows the schematic diagram of the technologies behind the speech-to-text service. A user speaks a speech which is then sensed by the built-in microphone and converted to a series of electrical signal. As background noise exists in the environment, the electrical signal consists of both the speech signal and the background noise. So, the electrical signal generated by the microphone will pass to a filter for noise cancellation and get a clean speech signal. In this first step, the technology applied is not intelligent. It is a simple signal processing technique.

For the second step, the clean signal is then passed to a voice-to-word module. The work to be done in this step is complicated.

- Word segment identification – To identify which part of the signal is likely to be a word.
- Word segmentation – Find and cut the signal into segments. Each segment corresponds to an unknown word.
- Word recognition – For each segmented signal, find out the corresponding word.

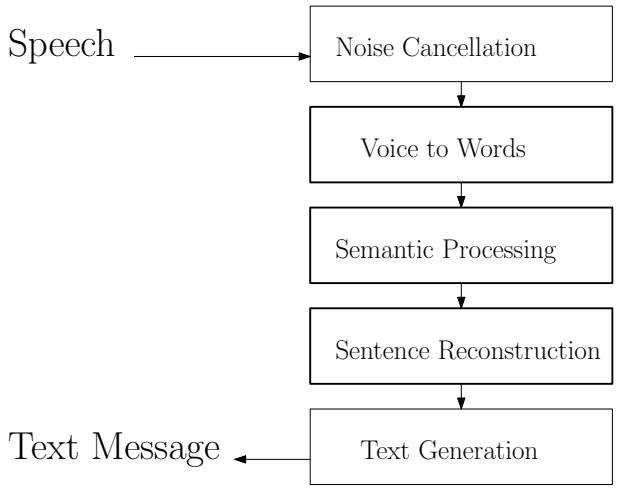

Figure 2: Schematic diagram for the speech-to-text service.

- Word concatenation – Combine the words to form a sentence.

After the second step has completed, a word strings will be get. For example, the sentence could read like below.

After the second step: **I an are hand some man**.

Clearly, this sentence seems not quite correct. So, this text message will then pass to another module for further processing. In this step, the technology for word recognition is an intelligent technology.

In the third and forth step, the string of texts will then be passed for semantic processing. This step is even complicated. So, I am not going to tell the detail. The result is that the module tries to find the appropriate semantic meaning of the text and makes correction. Finally, a new string of texts.

After the forth step: **I am a handsome man**.

Here, the technologies for semantic processing and sentence reconstruction are intelligent. In technical terms, they are natural language processing (NLP) or language understanding technology.

In the final step, the reconstructed text message is sent to the APP, like LINE and WhatsAPP, for display. Clearly, the technology for this step is not an intelligent technology.

1.6 Graphical Processing Unit (GPU): A Driving Force for AI

One important hardware which accelerates the advancement of intelligent technology is the graphical processing unit (GPU). GPU is a special-designed processor used to be applying in handle intensive mathematical calculations in

real-time video processing. Imagine that you are playing an on-line game, in which the background images have to be processed in real-time. As a general purpose CPU, like Intel CPU, normally takes much longer time to render the animation, the player will feel uncomfortable lag on the animation and thus quit the game. With a video card in which a GPU is installed, rendering animation would become a piece of cake. Uncomfortable lag is obsolete.

GPU is a processor designed particularly to handle specific mathematical calculations for image rendering and video processing. Its design is much simpler than a general purpose CPU which is designed to handle everything, like keyboard input, panel output, logical operations and arithmetic operations and others. Thus, the processing power of a GPU in mathematical calculations could be more than thousand time faster than a general purpose CPU.

As a GPU is particularly designed to handle mathematical calculations, it has then been applied to handle complicated and time-consuming learning algorithm. In the previous example about learning algorithm, the hypothetical model is simply a linear regressor. While the sample size N could be very large, say $N = 10^{12}$, the computational complexity (i.e number of multiplications) per step is just in the order of $\mathcal{O}(n)$, where n is the size of the parametric vector $\mathbf{b}$.

However, for some specific models like deep neural network models, the per-step computational complexity could be in the order of $\mathcal{O}(n^3)$ and n could be larger than 10^6. In this regard, the learning process would take weeks to complete in a computer with general purpose CPU only. Hence, in the 2010s, researchers in AI/ML started to map the learning process to GPU and demonstrated that the processing time for a learning could be reduced to just a few days and even a few hours[4]. Subsequently, many research groups followed and purchased GPUs to accelerate their researches on the development and the applications of the machine learning algorithms.

Therefor, GPU has to be worth mentioned with intelligent technology as it is a major driving force for the advancement of intelligent technology. In the early days, Nvidia is the major GPU designer and chip maker. Today, many firms have been involved in design and/or making GPU. Intel, AMD and Apple are three other players in the market. The A-series system-on-chip (SoC) processor by Apple has already embedded with multiple CPUs and multiple GPUs in it. Intelligent service developed from non-in-house Apple developers for such on-chip GPUs has yet to be explored.

1.7 Intelligent Services and Intelligence Infrastructure

In Section 1.5, we have mentioned two intelligent services, Siri and FaceID. As a matter of fact, various tech giants have already released a number of intelligent services on their cloud platforms. Here are some examples[5].

- IBM Cloud – Watson Speech to Text, Watson Text to Speech, Watson

[4] Search from the Google for the information about ImageNet competition and AlexNET.

[5] `https://www.datamation.com/artificial-intelligence/the-top-cloud-based-ai-services.html`.

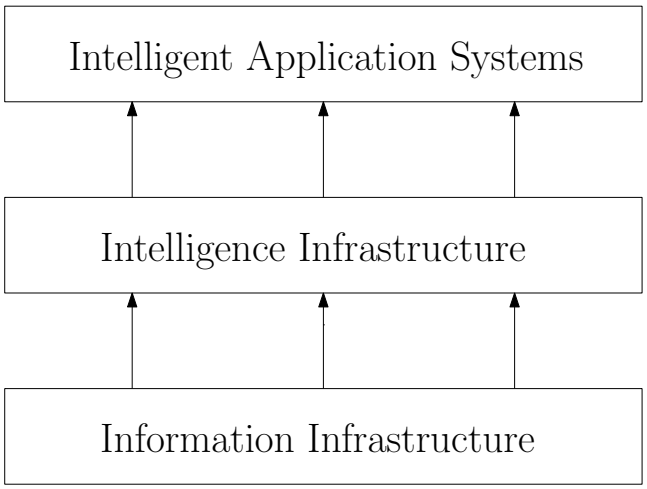

Figure 3: Intelligence infrastructure.

Language Translator, Watson Visual Recognizer, IBM Watson Services for CoreML, etc.

- Amazon Web Services – Amazon Lex (voice to text), Amazon Polly (text to voice), Amazon Rekonigtion for image analysis, Amazon Machine Learning, etc.
- Microsoft Azure – AI Services like Azure Cognitive Services and Azure Machine Learning; AI Tools and Framework; and AI Infrastructure, etc.
- Google Cloud – Cloud Vision API, Cloud Intelligence API, Natural Language API, Cloud Translation API, Speech-to-Text API, Text-to-Speech API, Tensor Processing Unit (TPU), other Cloud ML services.

These cloud platforms delivering intelligence services would serve as the intelligence infrastructures for the development of higher level of intelligence application systems, as shown in Figure 3.

Today, we have a lot more emerging technologies available in the *information infrastructure*. They include the personal area network (PAN), high speed wireless communication, Internet of Things (IoT), Internet of Vehicles (IoV), global positioning systems, mobile devices (smart phones, pads, watches and wearable devices), virtual reality (VR) headsets, augmented reality (AR) headsets like Microsoft Hololen, 5G communication technologies, cloud platforms and others.

The services delivered on top of this information infrastructure, like Google Map and Facebook, would definitely be facilitate the development of intelligent services to be added to the *intelligence infrastructure*. The pace of development could be far higher speed then ever.

1.8 Real World Applications

With the aforementioned technologies and other advanced technologies, a number of real world applications have been on the move. In a blog, Aayushi Johari has introduced 10 real world AI applications[6] in the areas of (1) marketing, (2) banking, (3) finance, (4) agriculture, (5) health care, (6) gaming, (7) space exploration, (8) autonomous vehicles, (9) chatbots and (10) artificial creativity.

Except that, AI had been successfully applied in automated mail-sorting machines in the US Postal Office. The key technology being applied is a neural network for optical character recognition which was developed by Yann LeCun and his collaborators in AT&T Bell Lab [7]. AI programs have been developed and applied in the US legal system [1].

AI programs have now been applied in scientific researches. Before 2000, AI program had been developed to read articles and then generate a summary for the articles [2]. Today, this technology has been even advanced. AI programs have been developed to read thousands of articles and generate a monograph [3]. These technologies could help a researcher to spend more time on the solution of a research rather than reading research articles. Even more, some AI programs are able to make hypotheses from the articles read [4]. Researchers could thus select from the set of hypotheses a few hypotheses for laboratory researches.

2 Course Content

2.1 Course Objectives

This course is served as a foundation course for the student to understand some important concepts and ideas in regard to intelligent technologies. Student will have to understand the evolution of technologies and then the intelligent technologies. Besides, applications of intelligent technologies for personal, business and industrial usages will be presented. The working principles of some commercial products which integrate multiple intelligent technologies will be covered.

With a comprehensive understanding, (hopefully) students could pursuit to understand how to "*manage the usage of intelligent technologies* and how to *manage the development of new intelligent technologies*"[8], i.e. *intelligent technology management* (or *management of intelligent technology*).

[6] `https://www.edureka.co/blog/artificial-intelligence-applications/`

[7] `http://yann.lecun.com/ex/research/index.html`.

[8] Precisely, *intelligent technology management* is about (1) the management of usage of the **intelligent technologies with access right granted**, (2) the management of the development of the new intelligent technologies and (3) the management of the **access rights** of the new intelligent technologies.

Similarly, *technology management* is about (1) the management of usage of the **technologies with access right granted**, (2) the management of the development of the new technologies and (3) the management of the **access rights** of the new technologies.

Management is about (1) the management of usage of the **resources with access right granted**, (2) the management of the development of the new resources and (3) the management of the **access rights** of the new resources.

2.2 Course Outline

This course will cover four major topics in intelligent technologies, including (i) the evolution of technology, (ii) introduction to intelligent products and services, (iii) mathematical theories behind intelligent technologies and (iv) analyzing the working principles of some intelligent products and services. If possible, advanced topics will be covered.

1. Course Introduction
2. Evolution of Technology
    (a) Industrial revolution
    (b) Automation and electrification
    (c) Information technologies
    (d) Intelligent technologies
    (e) Benefit and threads
3. Intelligent Products and Services
    (a) Key technologies
    (b) Working principles
    (c) My daily live and daily work
    (d) Go beyond
4. Essentials of Intelligent Technology
    (a) Technologies for language understanding
    (b) Technologies for image recognition
    (c) Core AI/ML technologies
5. Intelligent Services Development
6. Advanced Topics on Intelligent Technology
    (a) AI safety
    (b) Job replacement
    (c) Legal issues

2.3 Teaching Materials

There is no textbook and no PowerPoint slides available for this course. Materials, like papers and assignment sheets, will be distributed in the class or made available on the course homepage. The materials will cover, but not limit to, the following four types.

1. Notes on board.

2. Handouts and presentation slides.

3. Articles from journals, magazines and Google Scholar.

4. Videos available on YouTube.

Students are expected to bring with their own paper notebooks and drop notes. The notes include those information put on board and the information disclosed verbally.

2.4 Assessment

Written assignments in regard to the knowledge disseminated in the lectures will be issued. Moreover, selective articles will be distributed in the class. Students have to read the articles and answer questions regrading to their contents. Lastly, students have to complete a group project. They need to select a product and analyze which technologies has been applied to make it work.

1. Written assignments

2. Reading assignments

3. Project

   (a) Written report

   (b) Oral presentation

To assess the project quality, each group of students need to submit a written report. Besides, each group needs to give a presentation in the end of the semester.

It should be noted that attendance is not included in the assessment. It is the obligation of a student to attend all lectures.

2.5 Tentative Project Topics

Here is a list of tentative projects that you can attempt. Development projects are very technical. You need to have very good mathematical knowledge and good programming skill. For the analysis project, you can chose any one product or service and analyze the technologies being used. Besides, its current usage and potential future usage are surveyed. For the survey projects, student needs to select an AI related topic and conduct a survey on it.

1. Development Projects

   - Learning algorithm development project.
   - Technology development project.
   - Application development project.

2. Analysis Projects

- Analyze an intelligent product or service for personal use.
- Analyze an intelligent product or service for industry use.

3. Survey Projects
    - Industrial case study of an intelligent technology, product or service.
    - Survey on an intelligent technology and its applications.
    - Survey on automated hypothesis generation.
    - Survey on cognitive computing.
    - Survey on any AI related topic.

If you have a project in mind and it is not on the above list, you must talk to the instructor seeing if it is appropriate. Otherwise, your project score will get zero even if you have completed the written report.

3 MoI and Prerequisites

Here are some special notes on the medium of instruction and the prerequisites in regard to this course.

3.1 Medium of Instruction

While the medium of instruction of the course is not entirely in English, the materials and the notes on board are in English. The answers for the assignments and the project report should better be complied in English, while it is not compulsory. So, it is expected that the students should have a minimal level of English language standard, at least in reading and listening. All the emails to the instructor will be replied in English. Some videos, with English narration, about AI applications would be introduced in the lectures. Assignments about the videos could be issued.

3.2 Prerequisites

It is expected that **students should have knowledge in (i) undergraduate level calculus, (ii) introductory level of computer science with knowledge in programming and algorithms and (iii) undergraduate level of English**. Besides, **fundamental levels of logical thinking and procedural thinking** are needed. If you are not certain about these, you better not to take this course.

It is also expected that the **students are able to use Google searching engine and Google Scholar effectively** to aid their learning. Students are able to use at least one **word processing software**, MS Word for instance, to edit written documents; and to use at least one **presentation slide editor**, MS Power Point for instance, to edit presentation slides. While the uses of smartphone and computer are prohibited in the classes, students are expected

to use their **computers** at home for learning. Each student needs to have a valid **email account** for assignment submission, written report submission and communications with the instructor.

4 Class Schedule

In this semester, there are eighteen weeks of lecture. The ninth week is scheduled for mid-term examination. The eighteenth week is scheduled for final examination. The sixteenth week is scheduled for group project presentations. One week before the final examination, there is a lecture reviewing the materials being taught in the lectures. The duration of either mit-term examination or final examination is three hours. Detail lecture content to be delivered in each lecture is listed below.

Date	Lecture
September 9, 20020	Course Introduction
September 16, 2020	Evolution of Technology
September 23, 2020	Evolution of Technology
September 30, 2020	Intelligent Products and Services
October 7, 2020	*Paper Discussion (1)*
October 14, 2020	Intelligent Products and Services
October 21, 2020	Essentials of Intelligent Technology
October 28, 2020	Essentials of Intelligent Technology
November 4, 2020	*Paper Discussion (2)*
November 11, 2020	Essentials of Intelligent Technology
November 18, 2020	Essentials of Intelligent Technology
November 25, 2020	Intelligent Services Development
December 2, 2020	*Paper Discussion (3)*
December 9, 2020	Intelligent Services Development
December 16, 2020	Advanced Topics in Intelligent Technology
December 23, 2020	Advanced Topics in Intelligent Technology
December 30, 2020	*Project Presentation*
January 6, 2021	*Project Presentation*

Three sessions will be arranged for paper discussion. The papers will be distributed or announced in advance. Each student needs to read the papers and prepare a written comment for each paper. The written comments have to be submitted to a dedicated email account before their respective discussion sessions. In regard to the project, written report and presentation slides have to be prepared. They have to be submitted on or before the sixteenth week (December 23, 2020).

5 About the Instructor

Professor John Sum received BEng (Hons) in electronic engineering from the Hong Kong Polytechnic University in 1992, MPhil and PhD both in computer science and engineering from the Chinese University of Hong Kong in 1995 and 1998 respectively. Since 1990, John Sum has been interested in neural network (a research area under AI/ML) with particular focus on the theoretical analysis and design of learning algorithms. Thus, his undergraduate final project [5] (1992), master thesis [6] (1995) and doctoral dissertation [7] (1998) are all working in the area of neural network. Professor John Sum is a senior member of IEEE, affiliated with the IEEE Computational Intelligence Society and the IEEE SMC Society.

5.1 Working Experience in Hong Kong

From 1998 to 2004, Professor Sum taught in several universities in Hong Kong, including the Hong Kong Baptist University, the Open University of Hong Kong and the Hong Kong Polytechnic University. Moreover, he spent three months working as a senior research assistant with Professor Chi-Sing Leung (an academic senior of John Sum) in the City University of Hong Kong before moving to Taiwan.

5.2 Working Experience in Taiwan

In 2005, John moved to Taiwan and started to teach in the Chung Shan Medical University as an assistant professor in the Department of Information Management. He then joined the National Chung Hsing University as an assistant professor in the Institute of Electronic Commerce in 2007. He was promoted to associate professor and professor in the Institute of Technology Management in 2009 and 2015 respectively. From 2018 to 2020, John Sum was a distinguished professor. In 2010 and 2013, he was a recipient of the *Outstanding Research Award* from the College of Management of the National Chung Hsing University.

5.3 Teaching Experience in AI Related Courses

For almost thirty years, Professor John Sum has either been a tutor or an instructor teaching various AI related courses, including *Neural Computation* for both UG (BEng) and PG (MPhil, PhD), *Image Processing* for UG (BEng in CSE), *Artificial Intelligence* for UG (BEng in COMP), *AI & ML* for PG (MBA in TM), *Emerging Technologies with Business Applications* for PG (MBA in TM), *Intelligent Technology* for PG (MBA in ITM) and *Intelligent Technology Management* for PG (EMBA). Here, UG stands for undergraduate and PG stands for postgraduate including master and doctoral levels.

5.4 Research Interests

Professor Sum has very broad research interests including neural network, fuzzy system, job scheduling, parallel & distributed computing and service system engineering. Neural network has been his primary interest for decades starting from 1990. Some research results have been disseminated in 170 articles in journals and conferences[9].

5.5 Services

He has also served as a program committee member of various international conferences including ICONIP, ISNN and WIC. Occasionally, he has been invited to serve as a session chair for conferences, like ICONIP and TAAI. Besides, he was an associate editor of the *International Journal of Computers and Applications* from 2005 to 2009, a guest editor of *Neural Computing and Applications*, a guest editor of *Neural Processing Letters*, and was a governing board member of the Asia Pacific Neural Network Assembly (currently Asia Pacific Neural Network Society). Furthermore, he has been served as a reviewer for various journals and international conferences, notably the *IEEE Transactions on Cybernetics*, *IEEE Transactions on Neural Networks and Learning Systems* and ICONIP.

5.6 Further Enquires

For further information, one could access his official homepage `web.nchu.edu.tw/~pfsum` or send him enquire email via `pfsum@nchu.edu.tw`.

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