Importance of Including Practical Machine Learning Application in the Universities' Curriculum

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***Abstract*—In this paper, we would like to discuss making the curriculum about practical machine learning application for university students. They increasingly motivated to learn about machine learning by the industrial request and their career plan. Applications of machine learning are released quickly, and the curriculum of university is insufficient in correspondence. We focus on an importance of including practical machine learning application in the universities' curriculum and discuss these issues in this paper. Specifically, we provide a perspective about the necessary in the front end and the back end technologies. Machine learning technology should be blended into the back end system, and the front end system like mobile interface is very important point as the quality of service for the user. Today, students necessary learn a lot of learning contents about the quality of service with amount of time. The issues at universities are the fusion of new topics and the existing curriculum and the economic costs balance. Also discussion is necessary for social cooperation with the industries. The method of STEM education is important for such the practical machine learning application curriculum. We discuss the examples and effects in Japan.**

***Keywords*—Machine learning, Mobile, Back end technology, Curriculum, STEM Educations**

I. Backgrounds

In 2016 - 2017, AI "Artificial Intelligence" was noted as a topic in computer technology in Japan. This keyword was taken up not only in academic and IT industrial fields, but also in the general media. The citizens attentend to the impact of industries from AI services, for examples, home speakers, self-driving automobiles, medical diagnosis service. The speed of launch for AI services also became a factor of attentions in 2017. Almost every day, the AI application was reported in computer news media. This field has expanded to diverse - speech recognition, image processing, natural language processing, and corresponding practical services.

For example, IBM Watson was reported by National Broadcasting [1] that it did a diagnostic support for cancer patients and found another good therapy. Tokyo University used Watson in friendly cooperation with IBM for this project succeed. In the local governments in Japan, Sapporo City in Hokkaido established "AI Lab". The Sapporo area has been thriving in the IT industry for about 30 years. The AI Laboratory was planed for revitalizing the local economy by AI. Many IT engineers are talking about useful applications of AI through workshops and conferences in AI Lab [2]. It seems that AI has an enough possibility to restructure for the IT industries.

From such social background in Japan, university students are trying to catch learning opportunities for AI and machine learning. This university students mean students of engineering or information science department. The universities need to respond to it. Therefore, themes of discussion in this paper are issues for learning, constructing practical AI service at the universities.

II. Practical Medical AI Service

In this section, we show the necessary learning factors for constructing the practical service of AI. AI mainly refers to Machine Learning and Deep Leaning. We are researching and developing the practical medical service of machine learning as shown in Appendix A and B. The services shown in this appendix are newly developed for this paper and are not published as previous researches. Therefore, we show the machine learning classification ratings of these service in Appendix.

Appendix A is the pursuit of a practical model of machine learning. This service judges the authenticity of medical information on the Internet. This research should be integrated into the back end system, apart from this understanding, students must build a good user interface for a more better experience.

The research in Appendix B is a diagnostic support system for lung X-ray images using machine learning. It will place more nearly to the front end system. Students will focus on what the front-end system should be, depending on the user's request.

Such practical services are constituted by the accumulation of many technologies. Although students learn these elementary techniques individually in the university curriculum, they do not often implement them in the practical combination. Their element technologies in the Appendix show the relationship like Fig.1.

The machine learning service is handled in the same position as database like Fig.1. In the future there is a possibility that the machine learning system will be recognized as a excellent quality database.

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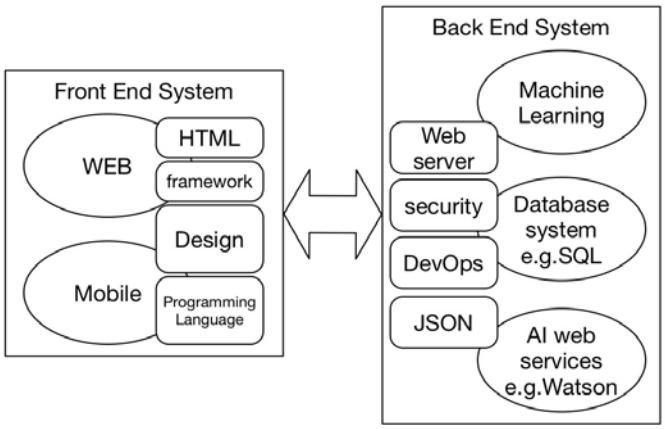

Fig. 1 "Element technology of practical application"

III. Element technology of practical application

In this section, we describe necessary element technologies for the practical services in the previous section.

A. Front end technology

1) Mobile technology: The mobile penetration rate in Japan exceeded 71.8% in 2016 [3]. University students have a strong desire to develop techniques of mobile front-end as constantly operating. The Java based Android development environment is easy to learn. The Objective-C based environment of iOS was difficult to learn, but in recent years this situation has changed since coming by Swift. Apple also released to handle the a machine learning classifier framework called Core ML.[1] With this framework, you can generate classifier applications on high-end mobile device. Fortunately, the cost of development environment for the mobile device is free, There are many learning information, so, the gap of learning is considered to be small.

2) Web-based server-side technology: Since the 1990s the center of Internet services is still in the web. In recent years mobile occupies the front end, but the enterprise intranet system still stays in the front end as the web, and this trend will continue for the foreseeable future. University students need to continue learning web technologies as basic knowledge of engineers.

B. Back end technology

Today backend service is a very important topic of service building. The elements that make up the backend are not limited to traditional databases. This subsection provides an overview of the topics that make up the back end.

1) Machine learning and deep learning frameworks: The machine learning framework has a long history and there are so many packages. Among them, the biggest impact was Google's TensorFlow released as a deep learning framework in 2015.[2] It was a factor of popularization that it was easy to make follow-up tests for the neural network model by Google in Appendix B. Other penetration machine learning frameworks are Caffe by the University of California, MXNet by the University of Washington and others. The other penetration factor is the completeness of Python for framework handling. This completeness refers to the abundance of readily available open source packages. The ecosystem of open source package related to Python has been completed by the developers community. The developer community has noticed the ease of Python learning, actively engages in collaboration with the machine learning framework, and is developing an excellent wrapper framework like Keras.[3]

2) Machine learning and deep learning web services: This subsection discusses the possibility of web based machine learning services for education. The completeness of Watson in section I is sufficient for education. At Watson web services - IBM Could[4], templates for building a front end application are prepared for each target OS - Android, iOS, web application. You can download skeleton of application of Java, Node.js for the web application, Android and iOS (Swift), Unity for the mobile application from github. Front end services are mostly prepared. A service instance of machine learning is provided on the cloud server and it returned the result to the front end. By referring to the provided sample code for visual recognition, web services will returned the probability of recognizing objects as JSON format like Appendix B . These web services do not cover all machine learning fields. However, this environment is sufficient for students to understand how to use machine learning and create service trial.

Microsoft Azure and Google Cloud also have similar features. A similar interface is prepared, and when you use resources heavily, you will be charged for pay-per-use. Even in any cloud machine learning environment it seems to be difficult to fine-tuning set up classifier modeling.

3) Network technology e.g. JSON: JSON (JavaScript Object Notation) is a lightweight communication protocol based on JavaScript notation.[5] JSON is not limited to JavaScript, it takes into consideration the possibility of being used for communication between all applications. JSON handling has many application packages. Handling at the front end is relatively easy.

4) Network security: Network security has become a very important topic in machine learning. The communications between the front end and the back end using e.g. JSON in the previous section should be encrypted for own privacy.

For that purpose, university students need to learn to integrate server side technologies such as Apache and SSL. Even on the front end side, they also have to acquire a handling of encryption keys.

When JSON communicates from the front-end application to the back-end system, it is obviously not encrypted. Therefore, JSON users must consider security, such as appropriate encryp-

[1] "Core ML Integrate machine learning models into your app." https://developer.apple.com/documentation/coreml
[2] "TensorFlow" https://www.tensorflow.org
[3] "Keras Documentation" https://keras.io
[4] "IBM Could" https://console.bluemix.net
[5] "Standard ECMA-404 The JSON Data Interchange Syntax" http://www.ecma-international.org/publications/standards/Ecma-404.htm

tion. The application providers may encrypt on the server side, they have the responsibility about it.

5) Server construction technology: Recent server technology is integrated with the cloud. The subsections III-B of IBM Cloud, Microsoft Azure and Google Cloud also integrate with the server service, and instances of machine learning can be handled simultaneously with instances of the cloud. Today the on - premise has become a legacy solution. It is outdated for everyone to set up a real server in their organization, frightening the privacy defense in addition to monetary costs. It is not necessary to suddenly cloud servers in your organization. It is best to gradually convert to cloud over the years. Several universities like Manhattan College have been moved to the cloud over the years.[6]

DevOps is another technology that university students have to acquire when considering an approach to server side technology based on cloud technology. DevOps here means not only co-operation between developers and operators, but also meaning to focus on "how to operate without stopping services". It is necessary to consider the user accessing any service regardless of 24 hours a day. Such technology is not content that can be learned in the lecture room, it may be more efficient to learn on an on-job training.

IV. Actual Issues

In this section, we describe actual issues in constructing a practical learning curriculum.

A. Integration with existing curriculum

The curriculum of computer science is divided into basic subjects such as mathematics and logic, basic computer subjects as computer languages, and other many fields - AI, computer graphics. In the case of Japan, in order to summarize these learning outcomes, the concrete practice is given to the research subject for graduation. I am not going to deny the way that has been adopted for a long time. It is quite natural for faculty members to instruct students while taking advantage of their expertise.

In Japan, the government decided to practical education rather than academic education from business and industrial request. They recently suspected that business scenes had changed quickly and that university education was not functioning well. Therefore, the Japanese government established a new university class "Professional University" for the first time in 55 years and accepted opening in 2019 [4]. This new class of universities is expected to place emphasis on vocational training required by industrialization of intellectual education such as Community College rather than university with an academic intensive type like American Polytechnics.

B. Machines cost

Machine cost is important in handling any project. The same goes for universities. The population of young people is decreasing in Japan, and in general the education budget tends to shrink in private universities. Against this background, learning environment costs of machine learning must be discussed well.

The cloud is very convenient, but costs exceeding a certain usage amount are costly. The cost of the cloud machine learning can be tried to some extent for free. However, it seems that many universities are difficult to respond to pay-per-use in Japanese research cost mechanism with heavy usage like research.

The most favorable aspect of Japanese educational institution is the annual depreciation method. If the university bought the educational environment with the budget for that year, and the value is zeroed over the years, management of the university will be very easy. In that way, universities need only calculate the necessary number of hardware comparable to machine learning. Currently, the hardware required for machine learning is a high-performance GPU, but the cost is greatly reduced. A GPU box is sold at around about $ 1,200 at low cost.

Of course, this discussion of cost has to be decided by what university students want to learn. For that, faculty members need to consider the curriculum adequately.

C. Learning to practical theme

We do not know well what kind of curriculum to train to build a practical application is ideal. Leaving it to the students' autonomy, there is one way to wait until the research for graduation like Appendix A. However, the education has no time. For this solution, cooperation with enterprises to effectively solve this that is indispensable for finding realistic application ideas and issues. One is an internship that has come to be well done in Japan, but many companies think that it is a process of selecting candidates for recruitment, so it seems difficult to find educational subjects.

Even so, it is certain that it is necessary to sufficiently reflect the opinion of industry professionals for building realistic applications.

D. Corporate cooperation

"Hackasson" conducted under corporate cooperation has an important meaning for future education. For example, "Hackasson" conducted with IT companies has become common in Japan. It is also effective to provide "Hackasson" theme by IT companies and use it for education of college students.

V. Conclusion and Discussion

The points that we would like to discuss at this conference are summarized below. This research has insufficient outcome, and it cannot show what kind of way is best as at least one university's curriculum. At least from social demands, university students should learn the machine learning technology that are positioned as conventional high-quality databases soon. And, It is desirable as a PBL subject based on the development of practical applications.

Even Japanese universities are doing some project on corporate cooperation and education of practical human resources. The Japan Ministry of Education, Culture, Sports, Science and Technology has been working on enPiT (Education Network

[6] "Power what ' s possible: Serving your communities better with Google Cloud Platform" https://events.educause.edu//media/files/events/annual-conference/2017/resources/power-whats-possible-serving-your-communities-better-with-google-cloud-platform.pdf

for Practical Information Technologies) from 2012 in cooperation with Japanese companies as a practical human resource education project at the graduate school. This project has been applied to undergraduate students since 2017. This project was conducted by PBL. The students learned the underlying curriculum and carried out the project in exercises. The example of machine learning classifier in Appendix A provides to this project and received the evaluation of the attractive idea from the IT company along with the student group within the HIU university.

We would like to discuss how to deal with in the field of STEM educations especially as quickly change targets like IT field. If we narrow down the target of discussion a bit more, One example topic is how to think about the balance between existing curriculum and PBL.

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APPENDIX A
CANCER INFORMATION DETERMINATION SERVICE

The Ministry of Health, Labor and Welfare of Japan points out the possibility that there may be information that seems to have no scientific basis for cancer information in "Basic Plan for Promotion of Cancer Countermeasures (Third Phase)" [6]. The countermeasure about it that is to make medical staff disclose information based on scientific evidence, but it is still not enough. It is desirable for the user to be able to judge the authenticity of information. However the user does not have sufficient medical knowledge. Therefore, using AI, we built a service that allows scientific evidence of information from the internet to be judged.

In the first, we decided to use the Cancer Clinical Practice Guidelines of Japan Society of Clinical Oncology as data to be learned by AI based on scientific evidence [7]. In this Clinical Practice Guideline data for patients with lung cancer, there are 1,917 sentences. This data is few for machine learning. However, it is also difficult to gather scientific evidenced data.

Second, we let this data be learned in the TensorFlow backend using character-level CNN. TensorFlow will be referred to the subsection III-B1. The character-level CNN is a machine learning method proposed by Xiang et al [8]. In general, CNN is a technique used for image classification and others, but it also applies to natural language processing. The character-level CNN processes does not require any unique Japanese word units processing against character units processing. Specifically, each guideline sentence was fixed-length array, vectorized, character-level CNN model was created. TableI contains Japanese example sentences and English translations used for testing and results of judgement.

The model compared with 1,000 Twitter search sentences about cancer. As a result, it was judged that 241 sentences were valid with a score of 0.95 or more in 1,000 sentences. The reason for selecting 0.95 depends on the convergence score at the time of learning.

From this result, there is a possibility that more than 70% of Twitter search documents is not based on scientific evidence.

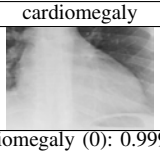
APPENDIX B
DIAGNOSIS SUPPORT APPLICATION FOR LUNG CANCER

The use of machine learning for medical images is a very powerful and expected technology. The advantage of machine learning is in high-performance classification ability [9]. So we implemented a practical system to support the diagnosis of lung cancer. There are a couple of important points. One important point is that the diagnostic part is part of the complex overall system. The meaning of a complex overall system is including many kinds of medical applications, - image transmission systems, patient information systems, electronic medical records and accounting systems. The lung cancer diagnosis support system must operate in cooperation with these. One way is to be

TABLE I. Results of relevance rate by character-level CNN model

Kinds	Japanese	Translated to English	Score
Nearly the Guide Line	肺がんの治療では、がんの三大療法である外科療法・化学療法・放射線療法が治療の基本となります。肺にできたがんが早期の内でリンパ節などへの転移がなければ、手術により約 70〜80%の肺がんを治すことができます。	In the treatment of lung cancer, surgical therapy, chemotherapy, radiation therapy, which are the three major therapies of cancer, are the basis of treatment. If there is no metastasis to the lymph nodes in the early stage of cancers made in the lung, surgery can cure about 70-80% lung cancer.	0.9797
Alternative therapy	心理療法や精神療法などのメンタル的な治療をはじめ、鍼灸やマッサージ、食事療法、運動療法、温熱療法、ハーブや健康食品を使った治療法など、実に数多くの種類が含まれます。	Alternative therapy are really many kinds. For example, acupuncture and moxibustion, massage, diet therapy, exercise therapy, hyperthermia, treatment using herbs and health foods.	0.7822

TABLE II. Recognition rate of the transfer classified model

cardiomegaly	nodule	mass
		
cardiomegaly (0): 0.999359 mass (2): 0.000624032 nodule (1): 1.65505e-05	nodule (1): 0.997746 cardiomegaly (0): 0.00153348 mass (2): 0.000720033	mass (2): 0.989304 nodule (1): 0.00727858 cardiomegaly (0): 0.00341696

independent of the complex system, it would be to implement an interface for communication. We adopted JSON and made this system an independent server. We used transfer learning which is easy to learn for machine learning by TensorFlow. Also, Python and TensorFlow were used for machine learning framework in this application.

First of all, The X-Ray image data set of NIH was used as the training data set [10]. Information on the location of the lesion was found in the NIH dataset, so we used this to identify the lesion and learning by the transfer learning. we extracted the part where the lesion information is clarified from 112,120 X-Ray files. In addition, 79 files each of Cardiomegaly, Mass, Nodule respectively, were extracted, and classifiers for judging 3 lesions were created by fine tuning of the Inception-v3 model [11] according to the method disclosed in the TensorFlow tutorial. The minimum number of lesions identified is 79 files. The learning time was about 4 minutes of CPU-based TensorFlow on Intel Core i5 in a Mac mini (Late 2014). Table II contains the recognition rate of the transfer classified model. Looking only at this result, it looks like a very good classifier, but there is a possibility of overfitting for this classifier. University students need to find research issues from here.

Next, we placed this classifier on the server and implemented it as a web service by JSON. The server system can be accessed from any application using JSON as an interface. For example, uploading a part of the lesion image to the server by e.g curl application, The web service sends to the client the result of classification - the probability of disease name. The server uses BaseHTTPServer, CGIHTTPServer in python packages for a simple web service.

In addition, we have implemented the front end of this system. This diagnostic support application is an application on iOS. The application sent a diagnostic image, and received the probability score of the cancer lesion. This application is created using Open Source JSON analysis library and Swift language. The application imports the X-Ray image by the camera, select the lesion area by user, and obtain the maximum probability of the lesion. A screenshot of the application in this project is shown below Fig.2.

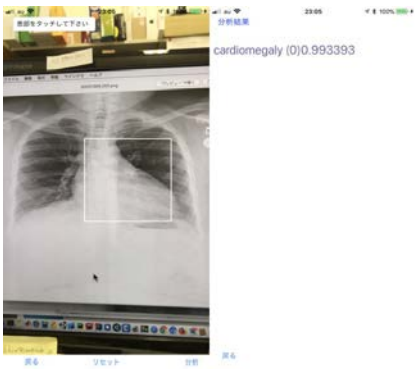


Fig. 2 "The front end mobile application"