UEC The University of Electro-Communications

UEC e-Bulletin

Updates on research, innovation, and events at UEC:
Unique and Exciting Campus in Tokyo

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The University of Electro-Communications 1-5-1 Chofugaoka, Chofu, Tokyo 182-8585

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Yuichi Sei Associate Professor, Department of Informatics, Graduate School of Informatics and Engineering, University of Electro-Communications.
Web Internet of Things for analyzing data while protecting privacy

Associate Professor Yuichi Sei's research is focused on analyzing data while protecting privacy. The background is to resolve privacy issues that arise due an increasing number of businesses using personal data that is collected from individuals, including voice, viewing, health, location, and train ticket gate data.

Notably, currently although such is data is protected it is also being provided to third parties after processing protection. So, there are increasing risks of leaks in privacy data.

For example, let's say a person uses social data such as Twitter and other social media, anonymously. This person is anonymous, but if we know that he often tweets about Chofu, conferences, research, and so on, we can assume that he is a university student or teacher near Chofu. If we know that he tweeted in August 2015, "What should I do about souvenirs for Helsinki soon. Then, we can deduce that he may be going to an academic conference in Helsinki around August 2015.

In addition, there is open data on "call for papers" on the web. The list of conferences is available, and papers submitted to conferences is also available. So it is easy to find a list of universities in Chofu. Also, universities generally publish lists of faculty members by job title and information on average income for each position.

By integrating this information, there is a risk that a third party, although anonymous, will be able to identify individuals, their occupations, and income levels. Furthermore, Tweets can be used to quickly make multiple guesses, which could be abused by third parties. Also recently, with advances in IoT technology, it is easy to obtain models trained for handling personal information, privacy-protected location data, health data, and other IoT data.

Although combining such "Web IoT Data" can be instructive, there are increasing risks from using inferred privacy information. Therefore, Sei and his colleagues are developing Web IoT that can understand and control privacy risks based on consideration of unexpected combinations, and performing machine learning and statistical analysis safely and with high accuracy, cross-sectional privacy protection, and data analysis.

They have proposed several privacy protection technologies, but the main target is to collect small amounts of perfect data without errors as personal data to be processed anonymously. For example, research has been conducted on obtaining accurate values without errors such as age, gender, and PCR test results.

“In the future, as IoT technology advances further, we will collect data that includes errors and defects observed in IoT and has many items, and analyze the data while protecting privacy for those data,” says Sei. An example of the research includes targeting data with inaccuracies such as age, gender, and the presence or absence of new coronavirus infection estimated from body temperature and perspiration volume produced by image recognition. They are developing technology for this purpose and collecting data for demonstration purposes.

It is essential that the method considers the errors and deficiencies in the data, so they have devised an algorithm for a new privacy protection index concept that protects real values that even the person himself does not know rather than protecting superficial ones. The measured values include errors and deficiencies.

Sei is also developing protection techniques that consider the combination of data, such as measuring the risk that data about the same person collected at different locations will be probabilistically identified as the same person when the data is published anonymously or processed anonymously.

Collecting actual data is one of the main problems to resolve in this research. So Sei and his colleagues are collecting experimental data by renting out two apartments in Chofu City, installing sensors and IoT home appliances, and asking participants to live in the apartments, and collected data, including personal data. In this way, they have also proposed methods and evaluating experiments based on actual data.

Fig 1 shows an example of some recent latest results assume a scenario where a person wants to know the histogram of the event participants' age from a camera image in a case where the resolution of the camera image is set to a low level for privacy reasons. In such a case, even if a machine learning model is applied, the accuracy of age prediction will be low for low resolution images.

Even if the prediction accuracy of individual machine learning models is low, Sei and his colleagues propose a technique to improve the accuracy of headcount counting. The black line shows the distribution of the data for the actual value shows the number of people by age group.

Drawing a line like this based on the prediction results for this age, the distribution will deviate slightly from the prediction, as shown in this baseline. However, their proposed method provides evidence that the statistical results are close to the actual distribution.

The second result is that of IoT data with many errors and deficiencies (Fig 2). Here when the analysis is carried out for multi-dimensional data based on such data, the amount of data with all the data is minimal, which makes it difficult to analyze.

Sei has also propose a method to reduce the error of the final statistical results by predicting the values corresponding to such missing data and thereby protecting privacy and has collected experimental data with various parameter settings and found that the proposed method has the smallest error.

In the future, Sei's goal is to release the infrastructure we have developed as open-source to create and promote services that allow people to use data safely and freely.

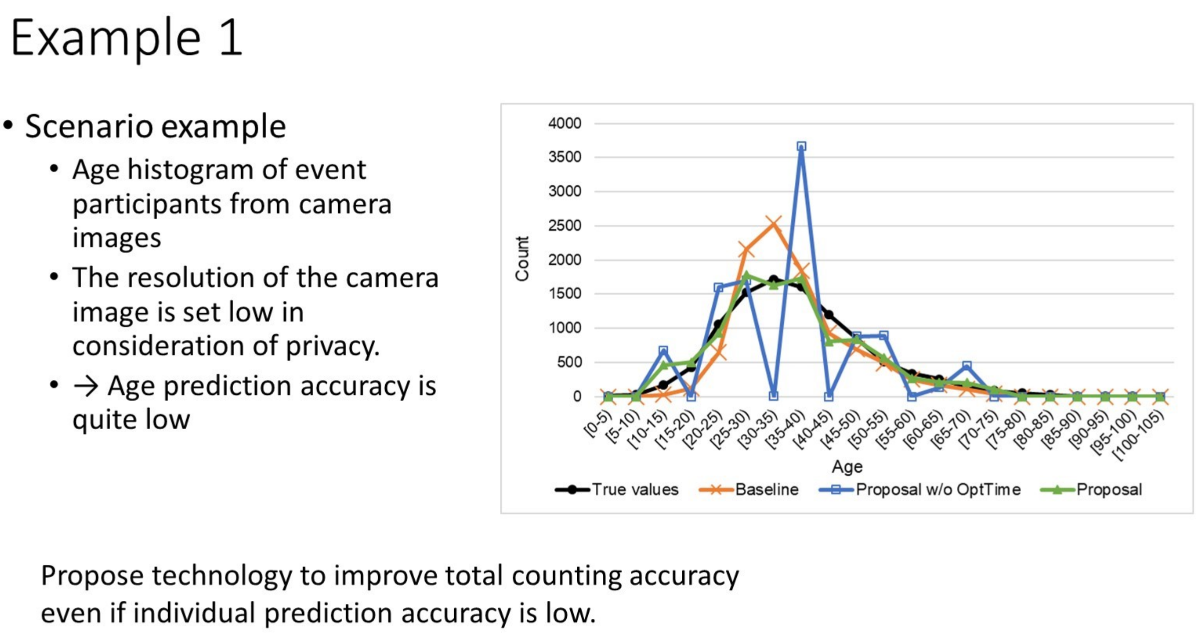

Figure 1 : An example of some recent latest results assume a scenario where a person wants to know the histogram of the event participants' age from a camera image.

Result 2

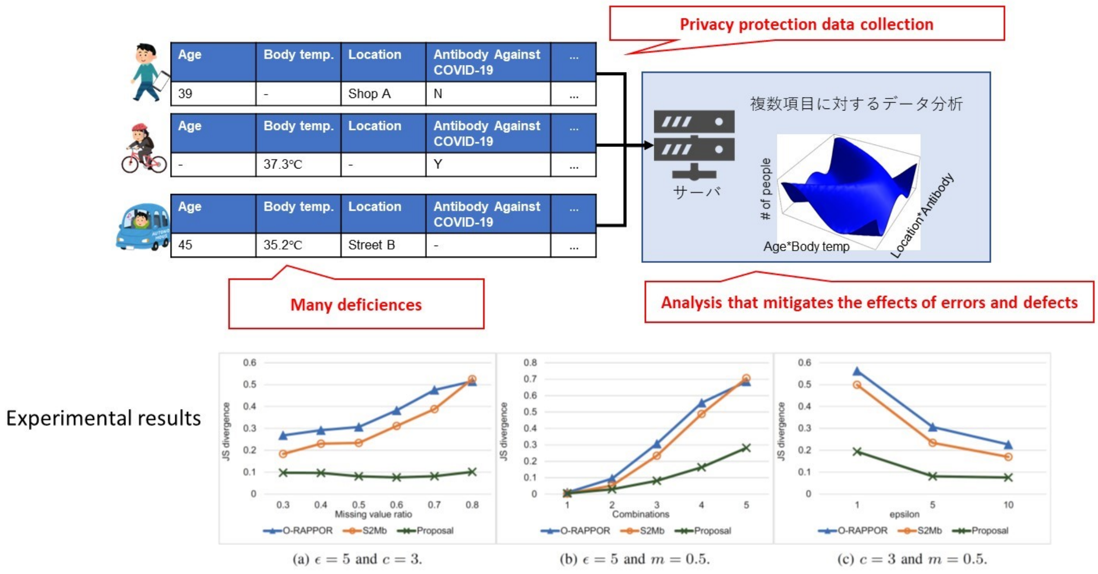

Figure 2: Results for IoT data with many errors and deficiencies.

Solid state physics
A candidate excitonic insulator under pressure

Insulators, by definition, do not conduct electrical current (in theory), and have a high electrical resistivity. Still, physicists distinguish between various types of insulators, differing in how the insulating states come about. The most common insulators are materials in which electrons cannot flow freely; too much energy would be required to ‘unbind’ them. Other types include Anderson insulators, in which electrons are ‘stuck’ because of quantum interference effects, and topological insulators, which are actually conducting at their surface. But one type of insulator, the so-called excitonic insulator, is particularly special — because it has never been unambiguously observed.

In an excitonic insulator, a low number of normally mobile electrons spontaneously bind (to so-called electron holes, having a positive charge) and become immobile. They were predicted to exist in the 1960s, and have been looked for in experiments ever since. Recently, encouraging possible signatures of the elusive excitonic insulating state have been observed in a layered material containing tantalum, nickel and selenium, with the chemical formula Ta_2NiSe_5. Now, Kazuyuki Matsubayashi from the University of Electro-Communications, Tokyo, Japan, and colleagues have probed the properties of this material under pressure. Their results help to close in on settling the question whether Ta_2NiSe_5 is an excitonic insulator or not — and excitingly, they show that it probably is.

First, the researchers measured the electrical resistivity of a Ta_2NiSe_5 crystal along the three main (crystallographic) directions at ambient pressure while varying the temperature. For all three directions, the resistivity dropped with increasing temperature, with an anomalous ‘kink’ at around T_C = 53 °C, the alleged temperature marking the transition to the excitonic insulating state.

The scientists then measured the temperature dependence of the resistivities with increasing applied pressure. Up to around 3 GPa, they obtained the same qualitative picture as before. But for higher pressures, resistivities first increased with increasing temperature, after which an anomalous decrease set in at around T^* = -100 °C.

The results of Matsubayashi and colleagues led to two insights. First, the anomalies at T_C and T^* probably have the same origin, suggesting that also at high pressure, the insulating excitonic state can develop. Second, by looking at the temperature dependence of the resistivity ratios, it becomes clear that dimensionality aspects play an important role in the formation of excitons — within certain layers of atoms, the conductivity is significantly different from that in the perpendicular direction. Rightly so, the researchers concluded that “these results deserve further high-pressure study to complete the phase diagram on Ta_2NiSe_5.”

Publication and Affiliation

H. Arima et al, Resistive anisotropy of candidate excitonic insulator Ta_2NiSe_5 under pressure, J. Phys.: Conf. Ser. 1609 012001, (2020), DOI: 10.1088/1742-6596/1609/1/012001

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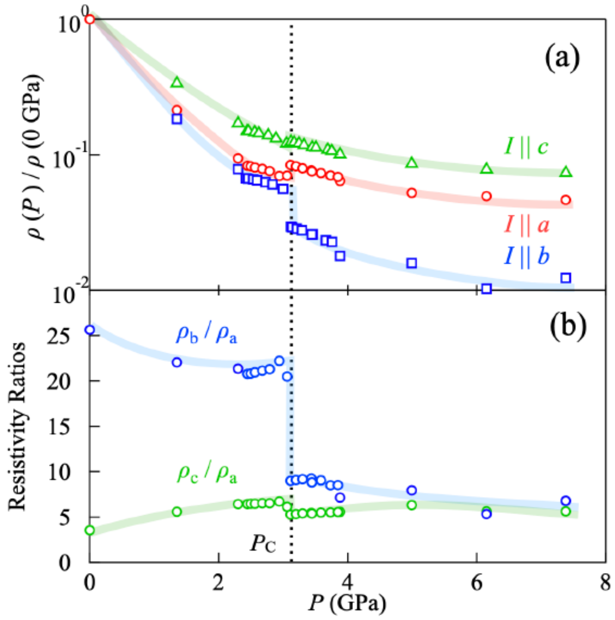
- Department website: http://www.m-lab.es.uec.ac.jp/Matsubayashi_Group/Home.html



[Fig. 2 from the paper]

Machine learning
Improving the counting capability of Internet-of-Things systems

Devices being able to automatically recognize objects, animals or people are becoming more and more widespread. Such automatic recognition usually involves sensors or cameras that are part of an Internet of Things (IoT) system, which connects to a neural network. Examining and classifying an object is then done based on machine-learning techniques.

Quite often, the required information behind automatic recognitions is a count — for example, the number of deer caught on a camera trap. Normally, the accuracy of such a count would depend on the accuracy of the machine learning model's recognition ability. For the camera trap example: if deer are recognized with low accuracy, the total deer count would also be of low accuracy. But now, Yuichi Sei and Akihiko Ohsuga from the University of Electro-Communications, Tokyo, Japan, have shown that it is possible to get good total count accuracy even with low recognition accuracy.

The researchers' trick lies in using a so-called confusion matrix, a table of percentages expressing how well the IoT system can distinguish recorded objects. For example, if the objects are deer, cats and dogs, the matrix contains information on how many times a deer is correctly recognized as such, or falsely as a cat, or a dog, and so on for all possible cases.

The confusion matrix comes into play after the IoT has been 'trained'. The latter means that from a large set of example images, of which the IoT is 'told' what is on it (for example a deer), the IoT's machine-learning model develops a procedure for deciding what is on a previously unseen image. Applying such a trained IoT is referred to as a baseline.

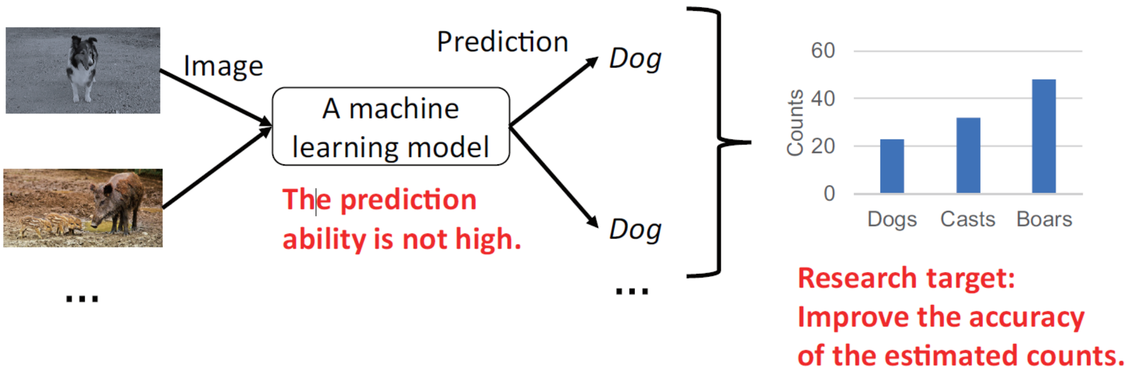
Sei and Ohsuga developed a way to compensate, as effectively as possible, estimated overall counts obtained in a baseline run for errors in individual object recognitions. They applied Bayes' theorem, a mathematical formula giving the probability of an outcome taking into consideration conditional probabilities that are relevant to the outcome in question. In the case of IoT object recognition, these conditional probabilities are related to the numbers in the confusion matrix.

The scientists applied their method using images of objects from a few image databases (for training, generating the confusion matrix, and testing) in six tests. On average, they found that the estimation errors were reduced by 64 % compared to the baseline runs.

The work of Sei and Ohsuga is innovative. Whereas previous studies have aimed to improve the classification accuracy for each individual observation, the present study aimed to improve the accuracy of total counts instead.

Publication and Affiliation

- Authors: Yuichi Sei and Akihiko Ohsuga.
- Title of original paper: Count Estimation with A Low-Accuracy Machine Learning Model
- Journal: IEEE Internet of Things Journal (early access)
- Digital Object Identifier (DOI): 10.1109/JIOT.2020.3038273
- Affiliations: Department of Informatics, Graduate School of Informatics and Engineering, The University of Electro-Communications.
- Department website: http://www.sei.lab.uec.ac.jp/



[Fig. 1 from the paper]

Caption: Objective of the research.

Innovative outlook for treating lazy eyes
Integrating polarized spectacles and smart tablets offers promising long term treatment for children's amblyopiams

Amblyopia also known as "lazy eye" is an eye disorder that results in poor vision of one eye. It is prevalent in children and young adults with 3% of newborn babies affected across all races. The most common treatment is covering the healthy eye with a "patch" and thereby forcing the other affected one to work harder to improve neurological connections with the brain.

However, eye-patching can lead to both psychological stress and physical skin rashes. So it is challenging to encourage children to wear an eye-patch for the long periods of time that is required for effective treatment.

Occlu-pad system

In an innovative alternative approach to eye-patching, Yo Ishigaki and colleagues at the School of Medicine of Kitasato University in Sagamihara, Japan, have developed new technology consisting of a pair of spectacles with a polarizing filter as one lens; a light reduction filter for the other; and a touchscreen tablet that has had its polarizing film layer removed. The spectacles are designed so that the lens with the polarizing filter covers the impaired eye and the one with the light reduction filter covers the healthy one.

"With our "Occlu-pad" system, children wearing our special glasses are only be able to view images emanating from the iPad through the eye with the polarized lens in their glasses," explains Yo Ishigaki. "The results of clinical trials carried our by doctors at Kitasato University showed that amblyopia training with our "Occlu-pad" system was significantly more effective than eye-patches for the treatment of this disorder."

The important point is that this system includes entertaining games that children enjoy playing and thereby wear the spectacles continuously for periods of times that are much longer than eye-patches.

"We worked with globally renowned game making companies to design enjoyable games for children," says Ishigaki. "Our system has a wide range of games and special glasses catering for children of all ages."

Global outlook

Japan has 30,000 patients per year (p/y), which is significantly lower than the USA 118,00 p/y; EU 153,900 p/y; China 506,000 p/y; and India 830,000 p/y. Ishigaki is focusing on supporting treatment of amblyopia in India by working with healthcare institutes in cities including Ahmedabad, Jaipur, Delhi, Mumbai, and Kolkata.

"The main issue that we must resolve for the proliferation of this system in India is cost," says Ishigaki. "The cost of an iPad is too high for most families in India. However, during my regular trips to visit collaborators in India I have realized that almost everyone has a smart phone. So I am working with colleagues in Japan to develop an Occlu-Smartphone system, which should be much more accessible to people in India and other parts of Asia."

[1] Yo Iwata et al, Evaluation of the Effects of the Occlu-Pad for the Management of Anisometropic Amblyopia in Children, *Curr Eye Res*, 43(6):785-787 (2018). doi: 10.1080/02713683.2018.1439066. Epub 2018 Feb 16.

The main components of the Occlu-pad system are spectacles with a polarizing lens and an iPad.

Ambassador of the Republic of Rwanda to Japan, H.E. Mr. Rwamucyo visits UEC

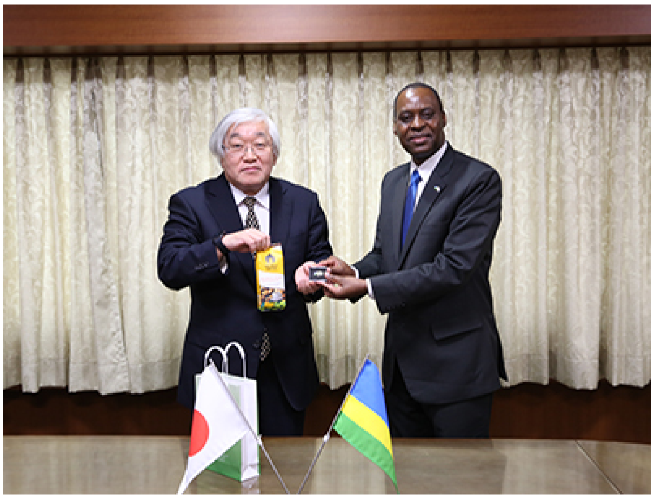
February 19, 2021

On February 17, 2021, His Excellency Mr. Ernest RWAMUCYO, Ambassador of the Republic of Rwanda visited the University of Electro-Communications (UEC).

H. E. Mr. Ernest RWAMUCYO and Ms. Yuri GODA from the Rwanda Embassy in Tokyo, were welcomed by President TANO Shunichi, Mr. UEMURA Takashi and Dr. ABE Kohji, the executive board members, Prof. OKAWA Tomio and Prof. YOKOGAWA Shinji, Info-Powered Energy System Research Center (i-PERC), and Specially Appointed Assoc. Prof. ISHIGAKI Yo, Department of Informatics, and they exchanged ideas on possible ways of research and education collaboration between the Republic of Rwanda and UEC.

After the meeting, Prof. ICHIKAWA Haruhisa and Prof. HAYASE Shuji of i-PERC gave research presentations for H. E. Mr. Rwamucyo at "Ambient Intelligence Agora", the active learning space inside the university library. Prof. Ichikawa made a presentation on Virtual Grid, the autonomous decentralized power network, and Prof. Hayase gave presentation on the Next Generation Perovskite Solar Cell. H. E. Mr. Rwamucyo enthusiastically asked questions after the demonstration of Prof. Hayase's laboratory experiments.

In November 2020, UEC donated 4,000 tablet computers to the Republic of Rwanda as part of the Smile Tablet Project, which is spearheaded by Assoc. Prof. Ishigaki and aims to enhance ICT in distance learning and education for environmental health all over the world. H. E. Mr. Rwamucyo described power supply situation of his country after the presentation ceremony of the tablets, and UEC gave introductory presentation of i-PERC and its efforts for global energy conservation and environmental solutions.
Taking this opportunity, UEC invited H. E. Mr. Rwamucyo to visit the university campus to explore ways to develop cooperation between the Republic of Rwanda and UEC.



UEC President Tano (left) and H. E. Mr. Rwamucyo

Demonstration at Prof. Hayase's laboratory

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of pure and applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Commutations, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus Tokyo.
With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few areas of research.
The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells.

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