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August 02, 2021 | Webinar

Machine learning-based self-powered acoustic sensor for speaker recognition

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Voice recognition is the most intuitive user-interface for bilateral communication between humans and smart devices. Speaker recognition has received spotlight as a next big thing of voice user interface (VUI) such as personalized voice-controlled assistant, smart home appliance, biometric authentication based on artificial intelligence (AI). The conventional speaker recognition was realized by a condenser type microphone, which detects sound by measuring the capacitance value between two conducting layers while supplying continuous power. The condenser type microphone, however, has critical demerits such as low sensitivity, high power consumption, and an unstable circuit due to the large gain amplification. Speaker recognition also suffers from a low recognition rate, caused by limited voice information and optimal algorithms for a simple and accurate process

Herein, we reported a machine learning-based multi-channel resonant acoustic sensor by mimicking the basilar membrane of human cochlear. Highly sensitive self-powered flexible piezoelectric acoustic sensor (f-PAS) with a multi-resonant frequency band was employed to fabricate the basilar membrane (BM)-inspired f-PAS. The speech waveforms of standard TIDIGITS dataset were recorded by the multi-channel f-PAS and converted into frequency domain signals by using Fast Fourier Transform (FFT) and a Short-Time Fourier Transform (STFT) to obtain the characteristics of frequency components. Gaussian Mixture Model (GMM) and Convolutional Neural Network (CNN) were utilized for speaker recognition, resulted in a distributed Stochastic Neighbor Embedding (t-SNE) plot of STFT feature between training dataset and testing utterance. Finally, the f-PAS achieved a 97.5% speaker recognition rate with the 75% reduction of error rate compared to that of the reference MEMS microphone.\

Biography

Keon Jae Lee received his Ph.D. in materials science and engineering (MSE) at the University of Illinois, Urbana-Champaign (UIUC). During his Ph.D. at UIUC, he was involved in the first co-invention of “flexible single-crystalline inorganic electronics”, using top-down semiconductors and soft lithographic transfer. Since 2009, he has been a professor in MSE at KAIST. His current research topics are self-powered flexible electronic systems including self-powered sensors/energy harvester, micro LEDs, neuromorphic memory/large scale integration (LSI) and laser material interaction for in vivo biomedical applications.

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Photonics approach to decision making

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Optics and photonics are expected to play crucial roles in artificial intelligence by utilizing the unique physical attributes of photons such as their ultrahigh bandwidth nature, light-matter interactions at the nano-scale, quatum properties, among others. Here we present our research on the physical realization or acceleration of higher-order intelligent functions such as decision making by exploiting photonics. Decision making means to conduct adequate judgements in dynamically changing uncertain environments and is widely utilized in information and communications technology ranging from resource assignments in networks to reinforcement learning in artificial intelligence. The problem of interest is the multi-armed bandit (MAB) problem where the issue is to maximize the total rewards in unknown environments that involve difficult trade-offs known as exploration-exploitation dilemma. We describe the principle of physically solving MAB problems by utilizing the wave–particle duality of single photons in which the probabilistic attributes of single light quanta are employed for exploration. The principle is transformed into ultrafast laser chaos where the chaotically oscillating irregular time series provides ultrafast and scalable decision- making abilities. Its applications to dynamic channel selections in wireless communications and dynamic model selection in reservoir computing will also be demonstrated. In addition, the MAB problem becomes more difficult when multiple players or social aspects are involved because decision conflicts evoke congestions that prevent from maximizing social benefits. We demonstrate that entangled photons perfectly resolve the decision conflicts and ensure equality thanks to quantum attributes of photons. Theoretical backgrounds will also be reviewed including category theoretical modeling and analysis.

Biography

Makoto Naruse received the B.S., M.S., and Ph.D. degrees in Engineering from the University of Tokyo in 1994, 1996, and 1999, respectively. After serving as a Research Associate and Assistant Professor in the University of Toyo from 1999 to 2002, he joined National Institute of Information and Communications Technology, Ministry of Internal Affairs and Communications, Tokyo, in 2002. In 2017, he was an Invited Processor of Univ. Grenoble Alpes, Grenoble, France. Since 2019, he is a Professor in the Department of Information Physics and Computing, Graduate School of Information Science and Technology, The University of Tokyo, Tokyo, Japan.

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Prediction of results of polymerase chain reaction from oligomer and DNA sequences using recurrent neural network

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Statement of the Problem: Polymer chain reaction (PCR) is a method for detecting pathogens and genes. In PCR, short chemically synthesized DNA (oligomer) binds to DNA (template) and a "complementary" copy of the template are synthesized by DNA polymerase from the end of the oligomer-binding positions. If the two oligomers are set to bind in the opposite direction of the template at a certain distance, DNA synthesized from templates and oligomers doubles with each reaction cycle. However, the binding of the oligomer to the template may be incomplete and produce copies of the unplanned position. As a result, pathogen-detecting-PCR may produce false-positive results even on a pathogen-free sample. Since the oligomers are designed at the thermodynamically optimal position in binding to the template, there was no technology for learning the false positive results to design better oligomers. Methodology & Theoretical Orientation: I and collaborators put the relationship between the oligomer and the template into a kind of words and define a pseudo-sentence as a set of words. Next, we focused on recurrent neural networks (RNN) as supervised learning for natural sentences. We accumulated the PCR results for each combination of the oligomer and the template and trained the RNN using the pseudo-sentences and the PCR results as a teacher. The trained neural network predicted PCR results from pseudo-sentence made from oligomers and templates, just as text was predicted by distinguishing it into fiction or current affairs news. Conclusion & Significance: RNN which predicts PCR results from the base sequences of oligomers and templates has the potential to revolutionize oligomer design for PCR when the prediction accuracy is improved with a large amount of data. In addition, changes in prediction accuracy due to changes in the method of creating pseudo-sentences provide suggestions for elucidating the mechanism of PCR establishment.

Biography

Endoh dropped out of Graduate School at Hokkaido University at the age of 25 and became an Instructor at Hokkaido University in the same year (1984). He received his PhD in a research-paper review when he was 36 years old (1996). He is a Professor of Radiation Biology and a Programmer who has been self-taught since the age of 18. He has published 54 papers, but only three papers have been published using bioinformatics since 2005.

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Investigating the micromechancis of granular materials using machine learning methods

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There is a dearth of machine-learning investigations of the micro-mechanics of granular soils. The micro-mechanics deals with the mechanics of granular materials at the micro-scale (often particle scale) or meso-scale and is contrasted with the macro-mechanics which focuses on the macro-scale behavior measured at the laboratory sample scale or field scale. In this talk, a poineering investigation of the contact force chains (CFC) in quasi-statically sheared granular materials using machine learning methods is conducted. an artificial neural network (ANN) based on discrete element method (DEM) simulation data is developed and applied to predict the anisotropy of CFC in an assembly of spherical grains undergoing a biaxial test. Five particle-scale features including particle size, coordination number, x- and y-velocity (i.e., x and y-components of the particle velocity), and spin which all contain predictive information of the CFC are used to establish the ANN. The results of model prediction show that the combined features of particle size and coordination number have a dominating influence on the CFC estimation. An excellent model performance manifested in a close match between the rose diagrams of CFC from the ANN predictions and DEM simulations is obtained. In addtion, some preliminary results of the prediction of the constitutive response of granular materials using the machine learning method are also presented.

Biography

Dr. Jianfeng Wang received his BSc and MSc degrees from Tongji University, China and his PhD degree from Virginia Tech, USA. Dr. Wang is internationally well known for his works in the field of micromechanical characterization and modeling of granular soils. Dr. Wang's work has been awarded the prestigious international prizes of 2011 Geotechnical Research Medal (UK Institution of Civil Engineers) and 2010 Higher Education Institutions Outstanding Research Award - Natural Science Award (the Ministry of Education of China). His research has attracted over 7 million HKD of external grants including the Research Grant Council (RGC) of Hong Kong SAR and National Science Foundation of China (NSFC). Dr. Wang currently serves as a Scientific Editor of Journal of Rock Mechanics and Geotechnical Engineering (The Chinese Academy of Science), and an Editorial Board Member of Soils and Foundations (The Japanese Geotechnical Society). So far Dr. Wang has published 80 SCI journal papers with a Google Scholar H-index of 26.

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Genetic algorithm for forecasting atmospheric air quality in Gdansk

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The use of Internet of Things nodes to assess air quality is becoming an important utilitarian and research problem. That is why so much work is devoted to both air quality data collection and forecasting capabilities. Therefore, the article is devoted to the possibility of collecting data in message brokers in Edge-Fog-Cloud networks and their processing of both integrated services as a genetic algorithm and external services, such as meteorological data.

The aim of the article is to show the processes of building a genetic algorithm for forecasting data on air quality in Gdańsk. The article is of a technical nature, showing on the one hand the necessary resources for the forecasting process, including air quality and atmospheric data. The structure of the Apache Kafka message broker collecting data from IoT nodes and reference devices and the structure of the Application Programing Interface for obtaining data from external air quality services are presented. It then shows the processes for creating phenotypes from the data collected in the topic for testing the genetic algorithm and its subsequent use.The construction of the genetic algorithm and phenotypes is carried out with the use of containerization processes carried out on clusters of virtual machines. An example of a cluster construction using the IaC -Infrastructure as Code approach, which allows the forecasting process to be treated as a sequence of commands from an IaC file, is shown. This file has been implemented in the Terraform environment.

Biography

Cezary Orłowski- Professor of computer science at WSB University in Gdańsk, head of the computer science group. He is a specialist in the application of IoT systems, Big Data pre-processing methods especially fuzzy and neuro modelling, building Infrastructure as a Code (IaC) and digital transformation in environmental engineering. He is also responsible for the Information Technology Research Laboratory- IBM Centre for Advanced Studies (CAS) using software delivered to the Department by IBM (main business and scientific partner). Additional information about book writing history, journal editorships, board memberships and any current leadership roles

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Classification of multiwavelength transients with machine learning

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With the advent of powerful telescopes such as the Square Kilometer Array and the Vera C. Rubin Observatory, we are enteringan era of multiwavelength transient astronomy that will lead to a dramatic increase in data volume. Machine learning techniquesare well suited to address this data challenge and rapidly classify newly detected transients. We will present a multiwavelength classification algorithm consisting of three steps: (1) interpolation and augmentation of the data using Gaussian processes; (2) feature extraction using wavelets; (3) classification with random forests. Augmentation provides improved performance attest time by balancing the classes and adding diversity into the training set. In the first application of machine learning to the classification of real radio transient data, we apply our technique to the Green Bank Interferometer and other radio light curves. We will show that we are able to accurately classify most of the eleven classes of radio variables and transients after just eight hours ofobservations, achieving an overall test accuracy of 78%. We present our investigation of the impact of the small sample size of 82 publicly available light curves and use data augmentation techniques to mitigate the effect. We also show that on a significantly largersimulated representative training set that the algorithm achieves an overall accuracy of 97%, illustrating that the method is likelyto provide excellent performance on future surveys. Finally, we demonstrate the effectiveness of simultaneous multiwavelength observations by showing how incorporating just one optical data point into the analysis improves the accuracy of the worstperforming class by 19%.

Biography

Kimeel is currently completing his PhD at Imperial College London. He completed his Masters at the University of Cape Town in 2019. He currently works on the application of Machine Learning techniques to prolems in Astrophysics.

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Forecasting probabilities of occurring the next possible word in a sentence in the online handwriting recognition systems

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In general, the prediction models are increasingly used for reasoning and decision making in various applications. Since, the demand of real-time based applications is increasing gradually due to the huge advancements in IT based devices such as Tablet-PC, touch-screen based smart phones, digital-pen/stylus based devices, digitizers etc. The present study describes about the forecasting probabilities of occurring the next possible Gurmukhi word in a sentence, which depends only on the immediately preceding word, written in the real-time environment. The online handwritten captured word information is first segmented into its individual strokes, which are recognized using Support Vector Machine (SVM) classifier. Thereafter, the bigram language model is utilized at stroke or character level in order to enhance the word recognition accuracy. The recognized word(s) is then used further to determine the occurrence of next possible word depending on their historical ability to forecast. Forecasting is a challenging task and totally dependent on the given data. In this study, the corpus, “Punjabi Monolingual Text Corpus-AnglaMT” (available at https://tdil-dc.in), containing approximately 83,000 sentences has been used for training the model. To overcome the data sparseness problem, the linear interpolation (Jelinek and Mercer, 1980) method is used for smoothing the n-gram estimates. The experiments show that the proposed online handwritten word forecasting framework significantly outperforms and produce consistent forecasts for the most likely word on the basis of given word.

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The new world order of technology and innovation: An analysis of how the investment on innovation based in artificial intelligence can modify today's industrial protection means

Giuliano Carlo Rainatto

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There is no acceptable definition for artificial intelligence (AI), one of which is that it is a computer system capable of solving complex problems (World Economic Forum 2018). The WIPO AI report and the highest order fields AI was the starting point for the construction of this exploratory, statistical study with surveys of WIPO, UNESCO, World Bank databases. The dichotomous assessment of how artificial intelligence can modify the protection system of innovations and especially the that has been done to adapt innovation protection systems to the new adjacent possible (Tria et al, 2017) created by this new technology. The institutions studied do not yet have a definition of how to protect inventions generated by AI in all environments and Investments have been made to understand how to patent these inventions. To measure the return on investment in research and Development is the volume of patents granted by the technologies studied, Asian countries studied hold 57% of the total high technology publication, compared to the traditional western countries, and this shift from high technology studies migrating from 2003-2004 to the East, indicates a polarization of technology exclusivity impelling the beginning of the "possible" new world order.

Biography

Giuliano obtained his first patent under the age of 33, and another two a few years later. He completed his master's degree before the age of 35 at a university in São Paulo. He is the director of modernization and digital transformation at the city of Guarulhos in São Paulo. He has published more than 20 papers in reputed journals and has been serving as an editorial board member of repute.

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August 02, 2021 | Webinar

Machine learning algorithms: Modeling the spatiotemporal dynamics of soil moisture under a forested site

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Statement of the Problem: The Atlantic Forest biome is one of the largest biodiversity hotspots in the world which is well-recognized by the ecological services, such as hydrological regulation and natural hazards mitigation. These services are mainly driven by soil moisture. The interactions among forest traits, rainfall patterns, climate, topography, and soil hydrology define the soil moisture spatiotemporal distribution. However, understanding these connections is arduous due to their high nonlinearity. This is even more challenging when extreme droughts are present. Although there are many physically based models, the correct definition of some parameters is an endeavor task. Therefore, machine learning algorithms have been a feasible alternative to model this ecological system tackling the nonlinearity. This study aimed to define the most appropriate machine learning to model the soil moisture spatiotemporal dynamics under an Atlantic forest stand.

Methodology & Theoretical Orientation: Random forest (RF), support vector machine, average neural network, and weighted k-nearest neighbor performance were assessed in a period spanning from 2012 to 2019. Calibration and validation were performed by two approaches: (i) chronological; and (ii) randomized. Explanatory variables were species diversity, diameter at breast height, throughfall, potential evapotranspiration, longitude, slope, and saturated hydraulic conductivity (Ks). Findings: The randomized approach is suitable to model the spatiotemporal dynamics of soil moisture in contrasting weather conditions since it enables machine learning algorithms to generalize. RF performed better than the others highlighting the importance of throughfall as the main driver of soil moisture dynamics. Tree diversity is related to soil water availability whereas Ks and slope were less important.

Conclusion & Significance: Both time-dependent and time-independent variables are important in modeling soil moisture in an Atlantic forest stand. Machine learning is recommended for stressful weather conditions.

Biography

André F. Rodrigues has his expertise in the hydrology of tropical forests with the main focus on understanding the connections among atmosphere, forest, and soil. He has worked with physically based models to simulate the rainfall canopy interception and the soil water movement in drought conditions. Since these connections had demonstrated high nonlinearity, he has dedicated his time to improve the understanding of the spatiotemporal dynamics of ecohydrological variables by means of machine learning algorithms.

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August 02, 2021 | Webinar

Maintaining proper health records improves machine learning predictions for novel 2019-NCOV

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An ongoing outbreak of novel coronavirus (2019-nCoV) pneumonia continues to affect the whole world including major countries such as China, USA, Italy, France and the United Kingdom. We present outcome ('recovered', 'isolated' or 'death') risk estimates of 2019-nCoV over 'early' datasets. A major consideration is the likelihood of death for patients with 2019-nCoV.

Method: Accounting for the impact of the variations in the reporting rate of 2019-nCoV, we used machine learning techniques (AdaBoost, bagging, extra-trees, decision trees and k-nearest Neighbour classifiers) on two 2019-nCoV datasets obtained from Kaggle on March 30, 2020. We used 'country', 'age' and 'gender' as features to predict outcome for both datasets. We included the patient's 'disease' history (only present in the second dataset) to predict the outcome for the second dataset.

Results: The use of a patient's 'disease' history improves the prediction of 'death' by more than 7-fold. The models ignoring a patent's 'disease' history performed poorly in test predictions.

Conclusion: Our findings indicate the potential of using a patient's 'disease' history as part of the feature set in machine learning techniques to improve 2019-nCoV predictions. This development can have a positive effect on predictive patient treatment and can result in easing currently overburdened healthcare systems worldwide, especially with the increasing prevalence of second and third wave re-infections in some countries.

Biography

Koffka Khan received the B.Sc., M.Sc., M.Phil., and D.Phil degrees from the University of the West Indies (UWI). He is currently a Lecturer at UWI and has up-to-date, published numerous papers in journals & proceedings of international repute. His research areas are computational intelligence, communication systems, information security and machine learning.

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