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Phung Trung Nghia · Vu Duc Thai · Nguyen Thanh Thuy · Le Hoang Son · Van-Nam Huynh *Editors*

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Keynotes

Exploitation of Electronic Medical Records

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Abstract Exploitation of electronic medical records (EMR) is a new, important, but challenging issue in healthcare in every country. It was started in Vietnam nearly 10 years ago, attracting and requiring much effort from the ICT community. This talk is about the story of EMR exploitation in Vietnam. It has been a long road in which our project has tried to identify the key issues to pursue and to develop the initial solutions along the way. I also point out that mathematics and informatics are essential in those solutions.

Advancing Slope Land Disaster Monitoring and Alert Systems through Synergistic IoT and AI Integration

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Abstract The escalating global vulnerabilities to natural disasters driven by climate change and geological instabilities have heightened the susceptibility of numerous nations. This presentation expounds upon the deployment of a comprehensive Internet of Things (IoT) framework seamlessly augmented with artificial intelligence (AI) capabilities to revolutionize slope land disaster monitoring and alerting. Within this framework, an assortment of sensor devices facilitates real-time data transmission to a centralized backend infrastructure. Through meticulous integration, an intelligent decision-making model is synthesized, empowering governmental bodies with a robust foundation for informed monitoring and dissemination, distinguished by green, yellow, and red alert levels. The adoption of these sophisticated disaster mitigation technologies adheres to internationally recognized geospatial standards. The incorporation of AI-driven disaster prevention systems refines the precision of essential information conveyance, empowering policy makers to promptly comprehend real-time disaster dynamics. This, in turn, facilitates the timely delivery of preemptive notifications to the populace, consequently mitigating the impact of impending disasters. The convergence of AI and IoT emerges as an indispensable paradigm, meticulously poised to fortify contemporary disaster management strategies.

Audio/Speech Information Hiding Based on Human Auditory Characteristics

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Abstract Audio information hiding (AIH) has recently been focused on as a state-of-the-art technique enabling copyrights to be protected and defended against attacks and tampering of audio/speech content. This technique has aimed at embedding codes as watermarks to protect copyrights in audio/speech content, which are inaudible to and inseparable by users, and at detecting embedded codes from watermarked signals. It has also aimed at verifying whether it can robustly detect embedded codes from watermarked signals (robust or fragile), whether it can blindly detect embedded codes from watermarked signals (blind or non-blind), whether it can completely restore watermarked signals to the originals by removing embedded codes from them (reversible or irreversible), and whether it can be secure against the publicity of algorithms employed in public or private methods. AIH methods, therefore, must satisfy some of the five following requirements to provide a useful and reliable form of watermarking: (a) inaudibility (inaudible to humans with no sound distortion caused by the embedded data), (b) robustness (not affected when subjected to techniques such as data compression and malicious attacks), (c) blind detectability (high possibility of detecting the embedded data without using the original or reference signal), (d) confidentiality (secure and undetectable concealment of embedded data), and (e) reversibility (removable embedded data from the watermarked signal and/or enable watermarking to be re-edited). In this talk, historical and typical AIH methods (including speech information hiding) are introduced and their drawbacks are pointed out. Then our proposed methods based on human auditory characteristics (cochlear delay, adaptive phase modulation, singular spectrum analysis with psychoacoustic model, formant enhancement, spread-spectrum with LP residue) are introduced. In addition, current research issues such as speech spoofing and deepfake detection will also be introduced.

Research on Intrusion Detection on Host Devices

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Abstract As networking applications prevail, network security threats also become worsen. Although deep learning-based intrusion detection systems (IDSs) are very promising, there are still unsolved issues: (1) Most of the IDSs are network-based IDSs; (2) Most of the IDSs are based on a single data source (mostly are network traffic); (3) Most of the IDSs do not differentiate different attack stages; (4) Training and testing data sets used by most of the deep learning-based IDSs are offline data sets that are from the public domain or collected by researchers through private experiments. Most IDSs do not consider decentralized learning by exploring the trust relationship between hosts. Our research aims to resolve these issues by developing a deep learning host-based intrusion detection system utilizing multiple data sources. A host-based IDS can be deployed on a personal computer, an application server, or a gateway of IoT devices. Compared to a network-based IDS, a host-based IDS can collect more critical security information, such as system logs and host statistics. These multiple data sources collected at a host benefit the intrusion detection process and preserve privacy. This talk will include three parts. The first part aims to develop a deep learning host-based intrusion detection system utilizing multiple data sources. It also aims to detect different stages of network attacks. In the second part, the trust relationship between hosts is utilized to develop a decentralized learning mechanism such that unknown attacks can be learned through decentralized learning. In the last part, semi-supervised mechanisms will be developed to conduct online learning, which could continuously re-train the deep-learning-based model to detect new network attacks.

Acknowledgements

We would like to express our appreciation to all the members of ICTA 2023' Program Committee for their support and cooperation in this publication. We would like to thank Prof. Prasanna Kumar (Production Editor) and Dr. Thomas Ditzinger (Executive Editor, Interdisciplinary and Applied Science, Engineering, Springer) for their support and cooperation in this publication. We also wish to thank all the authors and participants for their contributions and fruitful discussions that made this conference a success.

About This Book

Technological changes and digital transformation that have taken place over the past decade have had significant impacts on all economic and social sectors. Information and Communication Technology (ICT) in general and artificial intelligence (AI) in particular have driven socio-economic growth.

This book contains four keynote abstracts and 83 best peer-reviewed papers selected from the 179 submissions at the 2nd International Conference on Advances in ICT (ICTA 2023), which share research results and practical applications in ICT research and education. The topics cover all ICT-related areas and their contributions to socio-economic development, focusing on the most advanced technologies, such as AI. Researchers and practitioners in academia and industry can use the books as a valuable reference for their research activities, teaching, learning and advancing current technologies.

The Conference is hosted by the Thai Nguyen University of Information and Communication Technology (ICTU).

December 2023

Nguyen Huu Cong
Dongkyun Kim
Van-Nam Huynh
Le Hoang Son
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ICTA 2023

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About the Editors

Assoc. Prof. Phung Trung Nghia received his Engineering degree in Electronics and Telecommunications from Hanoi University of Science and Technology (HUST) in 2002. He completed his Master of Science in Telecommunications from Vietnam National University, Hanoi (VNUH) in 2007 and his Ph.D. degree in Information Science from Japan Advanced Institute of Science and Technology (JAIST) in 2013. He was Dean of the Faculty of Electronics and Telecommunications and Head of Academic Affairs. He has been ICTU's Rector. He has been the Vice President of the Vietnam Club of Faculties-Institutes-Schools-Universities of ICT (FISU) and President of the FISU Branch in the Northern Midlands, Mountains and Coastal Region of Vietnam. He received the Award for Excellent Young Researcher (Golden Globe Award) from Vietnam's Ministry of Science and Technology (MOST) in 2008. His main research interest lies in the interaction between signal processing and machine learning, and he has published more than 70 research papers related to this field. He serves as a technical committee program member, organizing co-chair, program co-chair, track chair, section chair, editorial board member and reviewer of several conferences, journals and books. He is an Associate Editor of Thai Nguyen University Journal of Science and Technology (ICT section).

Dr. Vu Duc Thai got a Master of Science in Computer Science from Thai Nguyen University and a Ph.D. degree in Mathematical Foundations for Computers and Computing Systems from the Institute of Information Technology—Vietnam Academy of Science and Technology in 2012. He has been the ICTU's Vice Rector. His research relates to databases, information systems and embedded systems (Cellular Neural Networks, FPGA). He has published more than 40 articles, books and book chapters. He works as an editor and reviewer for some international journals.

Prof. Nguyen Thanh Thuy received an Engineering degree in Computing in 1982 and a Ph.D. degree in Computer Science from HUST in 1987. He was a professor of computer science at HUST until 2011 and then at the VNU University of Engineering and Technology. Prof. Nguyen Thanh Thuy is now Head of the key laboratory for AI at the Faculty of Information Technology under VNU University of Engineering and Technology. His AI research interests are mainly in knowledge systems, soft-computing, data mining, deep learning, hybrid intelligent systems, general AI and responsible AI. Prof. Nguyen Thanh Thuy is now the President of the National Committee for Professorships of Vietnam in Computer Science (upon Ministry of Education and Training), period 2018–2023. He is also the Vice Director General of the National R&D Program KC-4.0/2019–2025 (upon MOST). He serves as Deputy Chief of Vietnam's National AI Strategy Council in 2020–2030 (established by MOST and other ministries). He keeps the role of the President of the Vietnam Union of AI Institutions and Industry (VINA3I) and the President of FISU, terms 2023–2028.

Assoc. Prof. Le Hoang Son is the Vice Director of VNU Information Technology Institute under Vietnam National University, Hanoi. His main research areas include soft computing foundation, knowledge-based systems, integrated machine learning for multimedia intelligence and multi-modal and environmental AI, with an interest in healthcare and telecommunications network applications. Some applications have been deployed recently with software copyrights, such as a medical imaging support system with a deep learning model and knowledge graph, semi-supervised systems in object detection on remote sensing images, large recommender system (Mega RS) with techniques to extract information on electronic medical records, the software analyzes facial expressions and supports dynamic decision-making. Dr. Son is an Associate Editor of Soft Computing (SCIE), Journal of Intelligent & Fuzzy Systems (SCIE), IEEE Access (SCIE), Data Technologies and Applications (SCIE), Neutrosophic Sets and Systems (ESCI), Vietnam Journal of Computer Science and Cybernetics and Vietnam Research and Development on Information and Communication Technology (2018–2020), VNU Journal of Science: Computer Science and Communication Engineering, Frontiers in Artificial Intelligence. He serves on the Editorial Board of Applied Soft Computing (SCIE), PLOS ONE (SCIE), International Journal of Data Warehousing and Mining (SCIE), International Journal of Web and Grid Services (SCIE) and International Journal of Ambient Computing and Intelligence (ESCI). Dr. Son has been a Vietnam Government Office Consultant (http://vpcp.chinhphu.vn/) since 2019. He received "VNU Young Scientific Research Award 2014", "VNU Annual Research Award 2015", "Vietnam Mathematics Award 2015" and a Certificate of Merit from the President of VNU for outstanding achievements in international publications and intellectual property in 2019 and 2020. He is on the list of 03 Vietnamese scientists in the list of the top 100,000 leading scientists in the world with the most significant influence of the five consecutive years 2019, 2020, 2021, 2022 and 2023.

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Artificial Intelligence

A Combination of Active Learning and Deep Learning for Improving Breast Cancer Prediction

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Abstract. In the field of modern medicine, biomedical informatics is crucial for enhancing illness detection, management, and treatment. A strong basis for applications that can enhance people's health and quality of life has been established thanks to the convergence of rich medical data with potent information technology. The detection and diagnosis of breast cancer is one of the key fields where biomedical data is used and labeled data plays an important role in supervised learning models. However, labeling data can costly and time consuming. In the field of breast cancer, there is a similar problem. So that, an approach will be proposed for automatic data labeling using active learning to improve breast cancer prediction by combining least confidence sampling with fine-tuned MobileNet model called BCPDAL. Experimental research on a number of fine-tuned deep learning models combined with uncertainty sampling methods and with the dataset used as BUSI. The results have shown that proposed approach BCPDAL can achieve 90% accuracy with only 50% of the labeled data samples in the entire original dataset.

Keywords: Active learning · Breast cancer · Classification · Uncertainty sampling · Labelling

1 Introduction

Biomedical informatics [1] has become an important field contributing to the improvement of diagnosis, treatment and management of diseases in the field of modern medicine. The combination of rich medical data and powerful information technology has created a solid foundation for applications that can improve people's health and quality of life. There have been many researches and projects on biomedical informatics in life such as: Human Genome Project, Medical Image Analysis, Disease Prediction and Epidemiological Analysis, and so on. One of the important applications of biomedical information is in the field of breast cancer detection and diagnosis [2].

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As reported in [3], Breast cancer is one of the most dangerous and common diseases, especially in women. According to statistics from [4], the number of new cases was 2,261,419 with the number of deaths being 684,996 in 2020. Because of that, early detection of breast cancer will make treatment more effective [5]. One of the ways to detect that is based on images such as: x-ray, ultrasound, etc [6]. From these image data, there have been many studies in building supervised machine learning models to detect and diagnose of the disease based on these breast cancer images [7]. However, the application of supervised machine learning models [8] requires a labeled dataset. The construction of these labeled datasets is very expensive in terms of money and time. And much of the current breast cancer imaging data remains unlabelled. Because of that, in this study, the authors propose an approach in automatic data labeling based on active learning [9] to improve breast cancer prediction by using a combination of fine-tune MobileNet and least confidence sampling. It is called BCPDAL (Breast cancer prediction based on deep active learning). Experimental research on proposed approach and other models combined with uncertainty sampling method [10]. The BUSI dataset [11] is used for experiment and the results have shown that proposed approach will result in 90% accuracy with only 50% of the data in the entire original dataset. The main contributions of this study include:

– Propose an approach using active learning to the breast cancer prediction results in case of very rare data. Find good labeling strategy through evaluation and comparison between different strategies.
– Combine active learning with deep learning, find a suitable model, hyperparameters and fine-tune the deep learning model to help bring the best results to the problem of data labeling with the data set in use.

This article is divided into 5 sections. The first section is an introduction. The next section is related works. The third section is the proposed method. The fourth section is the experiments and final is the conclusion.

2 Related Works

The problem of missing data is one of the most difficult problems in model training with supervised learning. And the same goes for breast cancer. In our knowledge, the application of active learning in the automatic labeling problem to enhance the data and improve the accuracy of the model is very little. The paper [12] is one of the few studies in this area.

In [12], the authors proposed a method called Reversed Active Learning (RAL) to train the CNN model in the breast cancer classification problem. CNN combines with RAL to remove mislabeled data. This study experimented on the ICIAR 2018 Breast Cancer Dataset (IBCD) with an accuracy of 93.75–96.25%.

Authors in [13] proposed an active learning framework on breast cancer detection using an ensemble learning. In this framework, the authors have combined many machine learning models such as: KNN [14], SVM [15], Naive Bayes [16], logistic regression [17], random forest [18] and gradient boost [19]. The experiments were performed on the The Cancer Genome Atlas (TCGA) dataset [20]. The results obtained from the association framework are very satisfactory with an accuracy of 83–98% depending on the classified class.

In [21], a strategy called Batch Active learning by Diverse Gradient Embeddings (BADGE) is proposed based on kMeans++ [22]. This method selected samples based on hallucinated gradients. Since the usage data do not have the true labels available, this hallucinated gradient should be used. Importantly, BADGE trades off uncertainty and diversity without requiring any manually adjusted hyperparameters. While other methods were sometimes successful for specific batch sizes or structures, BADGE always performs as well or better, making it a useful choice for active learning problems in the real world.

3 Proposed Approach

Figure 1 depicts BCPDAL to data labeling and improve breast cancer prediction based on active learning technique [9] for breast cancer imaging data. In which, the combination between the uncertainty sampling methods [10] with other fine-tuned deep models in turn to compare with proposed approach. In addition, the data before being input into the deep learning model will undergo a pre-processing step to increase the image contrast.

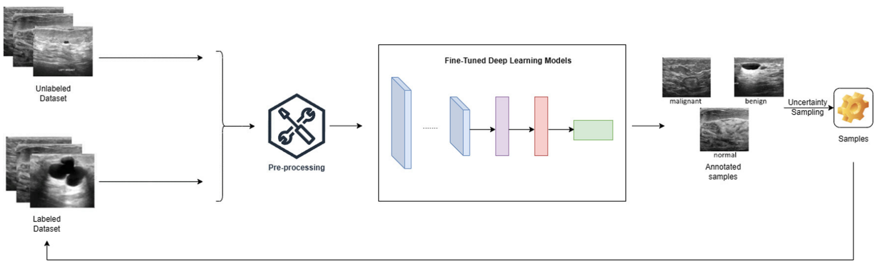

Fig. 1. The proposed approach—BCPDAL.

3.1 Sampling Methods

Uncertainty Sampling [10] is a technique for selecting data samples so that these data samples make the predictive model the least confident to label the data. The goal of this technique is to find data samples that can overcome the weaknesses of the current model. In this paper, three sampling methods will be used includings least confidence, margin sampling and entropy-based sampling.

Least confidence method [10] is focus on selecting the samples that the machine learning model has the highest probability of predicting but is not confident enough in its predictions. Let L be labeled dataset, U be unlabeled dataset, $D = L \cup U$ be all data includings labeled and unlabeled dataset, x be sample in D, $S(x)$ be least confidence score of sample x, $\hat{y}_{max}$ be the model's highest confidence prediction, and $P(\hat{y}_{argmax}|x)$ be predicted probability of the class with the highest probability by the model for sample x. The least confidence score is calculated by formula (1).

$$S_{LC}(x) = 1 - P(\hat{y}_{argmax}|x) \tag{1}$$

Formula (2) represents the margin sampling method [10]. In a classification problem, choosing samples where the model has difficulty distinguishing between two classes can improve the model's performance on new data. In which, $S_M(x)$ is margin score, $\hat{y}_{max}$ is the model's highest confidence prediction and $P(\hat{y}_2|x)$ is the predicted probability of the second lowest probability class by the model for the sample x.

$$S_M(x) = P(\hat{y}_{argmax}|x) - P(\hat{y}_2|x) \tag{2}$$

The final sampling method used in this paper is entropy-based sampling [10]. Let $S_{EB}(x)$ be entropy-based score of sample x. The entropy-based score is calculated according to the formula (3).

$$S_{EB}(x) = -\Sigma_{y \in Y} P(y|x) log_2 P(y|x) \tag{3}$$

3.2 Fine-Tuned Deep Learning Models

To increase the accuracy of feature extraction and classification in deep learning models, a sufficiently large amount of data is required. However, for diseases such as breast cancer, the data analyzed is very limited. Transfer learning method is one of the solutions to overcome this limitation. Fine-tuned pre-train models can result in higher performance for the problem to be solved.

In this paper, different fine-tuned learning models will be performed to improve the results for the applied problem. The weights of the pre-train models still on the ImageNet set are still used in this study. Figure 2 shows an illustration for the fine-tuned deep learning model.

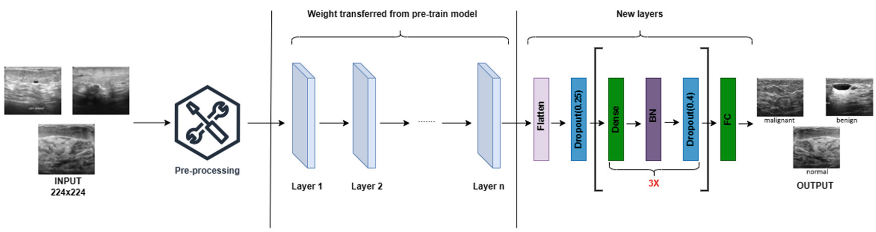

Fig. 2. An illustration of deep model for improving breast cancer prediction.

In the proposed fine-tuning model as Fig. 2, following the layers of the pretrain model is a flatten layer for the purpose of reshape a tensor and dropout layer to skip some units during training in the model, this helps to reduce the overfit rate of the model. This is followed by a set of 3 layers includings dense, batch normalization and dropout that they are repeated 3 times. Final is fully-connected layer. In this study, the fine-tune techniques will be applied for the MobileNet model and other models with purpose for comparison in the experimental section.

4 Experiments

4.1 Dataset and Hyperparameters

Breast Ultrasound Images (BUSI) is a dataset that is published in [11]. This dataset was collected from women aged 25–75 with a total of 600 patients. The included dataset was classified into 3 classes: 210 images for malignant, 437 images for benign, and 133 images of people without disease. All images are saved in PNG format with an average size of 500x500. From the original BUSI dataset, data will be splited into three parts at a ratio of 2.5–77.5-20 consisting of 2.5% for labeled data and 77.5% for unlabeled data and 20% of data used for testing. This labeled data will be the first training set for the fine-tuned models and the unlabeled set to apply the sampling method as described above.

In the experiment, hyperparameters will be used as epoch = 10, 20, 30, learning rate = 0.1, 0.01, 0.001, hidden unit = [512, 256, 128], [256, 256, 64]. The results will be shown in Sect. 4.2 that collect from best hyperparameter set includings epoch = 20, learning rate = 0.001, hidden unit = [512, 256, 128], [256, 256, 64].

To train the models and evaluate the proposed method, Python language is used with two main supporting libraries, tensorflow and keras. The experiment was carried out on a computer with a configuration including Windows 10 64-bit; Intel Core i5-12400F CPU @ 2.50 GHz × 12; and 32 GB of RAM, and NVIDIA GeForce RTX 3060 12 GB VRAM graphics card.

4.2 Evaluate the Experiment Results

The purpose of this experiment is to evaluate BCPDAL and compare with combination between other deep models and strategy sampling in uncertainty sampling.

Figure 3 shows the results of the labeling process with different models using *hidden unit* = {*[512, 256, 128]*}. From above result, BCPDAL just assigning labels to 340 image data samples (At the 17th step, this equates to 56.6% of the dataset) can achieve an accuracy of 87%.

Figure 4 shows the results of the labeling process with another hyperparameter *hidden unit* = {*[256, 256, 64]*}. With the least confidence method, the proposed approach achieves 90% accuracy with only 320 labeled data samples