Lecture 1 - Deep Neural Networks and Machine Learning Applied to Differentiation of Primary Lung Tumors from Metastases in Computed Tomography Exams

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Abstract. Lung cancer is the type of cancer with the highest mortality rate in the world. The determination of the etiology of this cancer, regarding its primary or metastatic nature, is one of the factors which can influence the patient's prognosis and clinical management. How Neural Networks Deeps are shown as an efficient approach to classify images in several areas, with emphasis on radiology for Convolutional Neural Networks (CNN)). However, like any learning approach deep, since CNNs require a large volume of annotated data. An alternative to meeting this need is to increase databases using geometric transformations such as rotations and mirroring. In this context, the objective of this research was to investigate The hypothesis that deep CNN-type networks, such as VGG19, ResNet152V2 and InceptionV3, trained on image databases, was able to identify from segmented tumors in computed tomography images, whether lung cancer has a primary pulmonary origin or was developed from a metastatic process from a primary site located in another organ. We also combined these networks with the Support Vector Machine to explore more machine learning techniques. We realized our experiments separating the data into independent training and test groups. In the training group, a 10-fold cross validation was applied. The best results were obtained using ResNet152V2 with an increased base, delivering an Area under the ROC Curve with an average of 0.74 (standard deviation of 0.7), F-score with an average of 76% (standard deviation of 7.0%), Accuracy with an average of 74% (standard deviation of 7.0%), Sensitivity with an average of 80% (standard deviation of 12.0%) and Specificity with an average of 69% (standard deviation of 16.0%) in the cross validation test base. In the evaluation of the independent test base, the values obtained were 0.78 for AUC, 66% for F-score, 79% for Accuracy, 75% for Sensitivity and 80% for Specificity.

Keywords. Artificial intelligence; Convolutional Neural Networks; Radiomics; Neoplastic metastasis; Primary neoplasms.

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Bio sketch. Dr. Lucas Lins de Lima, currently a professor of Computer Science at Universidade Paulista (UNIP - Ribeirão Preto campus). He holds a PhD from the Interunit Postgraduate Program in Bioengineering at the University of São Paulo (PPGIB-USP) (2024), a Master's Degree in Computer Science from the Postgraduate Program in Computer Science at the Federal University of Alagoas (PPGI-UFAL) (2019) and a Bachelor's Degree in Computer Science from the University of Alagoas (UFAL) (2016).

Lecture 2 - Machine Learning and Infrared Spectroscopy Applied to Histopathological Diagnosis

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Abstract. Computational analysis based on pattern recognition in medical images has been extensively explored over the past decades, particularly in the field of radiology. Another modality of medical imaging that has gained attention in recent years is microscopic imaging obtained from histological samples. The significant structural differences between these images and radiological images demand the study and implementation of new computational techniques for their processing and analysis. More recently, the study of hyperspectral images, acquired through infrared spectroscopy applied to tissue samples, has provided new tools for identifying the physical and pathological characteristics of tissues. This seminar will present some studies conducted by the CABI (Computing Applied to Biomedical Information) research group from FFCLRP-USP, focusing on the application of conventional machine learning techniques as well as advanced deep learning-based approaches to both conventional and hyperspectral histological images. The results of these studies demonstrate the significant potential of machine learning for medical imaging analysis and highlight the contribution of histological and hyperspectral imaging modalities to increasing the effectiveness and the reach of computational applications for diagnostic support.

Keywords. Machine Learning; Deep Learning; Infrared Spectroscopy; Histopathological Diagnosis.

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Bio sketch. The author holds a Habilitation (Livre-Docência) from the University of São Paulo (USP) (2017), a Ph.D. in Computer Science from USP (2005), a Master's degree in Computer Science from the Federal University of São Carlos (2000), and a Bachelor's degree in Mechanical Engineering from USP (1986). Currently, he is an Associate Professor (MS-5) at the Faculty of Philosophy, Sciences, and Languages at Ribeirão Preto, University of São Paulo (FFCLRP-USP). He teaches undergraduate courses in Computer Science and Biomedical Informatics and contributes to graduate programs in Applied Computing and Bioengineering. Throughout his academic career, he has held leadership roles, including Chair of the Undergraduate Committee at FFCLRP-USP and Chair of the Coordinating Committees for the Biomedical Informatics and for the Computer Science undergraduate programs. His research activities focus on Biomedical Information Computing, focusing primarily on the following topics: image processing and analysis, computer vision, computer-aided diagnosis, and content-based image retrieval.

Lecture 3 - Digital Public Health: Challenges and Opportunities

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Abstract. In this talk, we will review the evidence on digital technologies and some important ways in which these tools can be used to maximize impact on health systems and people's health. Indeed, the use of digital technologies offers new opportunities to improve people's health, but the evidence also highlights challenges in the impact of some interventions. Digital interventions depend heavily on the context and ensuring appropriate design, including structural issues in the environments where they are being used, available infrastructure, the health needs they are trying to address, and the ease of use of the technology itself. In this sense, we will show some advances and barriers in this very current area in the scientific context, including the issue of system interoperability, development and implementation of decision support tools using artificial intelligence, mobile applications in public health, etc.

Keywords. Public Health; Digital Technology; Artificial Inteligence; Mobile Applications.

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Bio sketch. B.Sc. degree in Physics from the State University of Campinas (1986), master's degree in Physics from the State University of Campinas (1993), PhD degree in Physics from the University of São Paulo (1999), two postdoctoral degrees from the University of São Paulo, one from the Institute of Physics of São Carlos (2000) and one from the Faculty of Pharmaceutical Sciences of Ribeirão Preto (2001). He is currently an associate professor in the Department of Social Medicine at the Faculty of Medicine of Ribeirão Preto, USP. He also serves as a collaborating professor at the Center for Health Technology and Services Research (CINTESIS) of the Faculty of Medicine of the University of Porto. He is the leader of the Health Intelligence Laboratory (LIS) registered and certified in the CNPq group directory (http://dgp.cnpq.br/dgp/espelhogrupo/7944739360325525). He is also coordinator of the Information Management and Informatics area of the TB Network and a member of the National Institute of Science and Technology - Tuberculosis (INCT-TB) since 2018.

Lecture 4 - Advancing the future of healthcare through innovation.

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Abstract.

The SUPERA Innovation and Technological Park in Ribeirão Preto, São Paulo, Brazil, has established itself as one of Brazil's leading innovation ecosystems, gaining global recognition for its significant impact on the health, agribusiness, and information technology sectors. Comprising 80 companies, 68% of which are healthtechs, the technology park fosters a dynamic environment for entrepreneurship and innovation. In 2022, it achieved remarkable results: R$ 7.7 million in private investments, R$ 48.5 million in revenue, and the creation of 534 jobs. Through strategic partnerships with renowned institutions such as USP, FAPESP, and CNPq, along with government support, SUPERA offers robust infrastructure and services in intellectual property consultancy, testing and trials, training, and market connections, positioning itself as an essential hub for cutting-edge technology development.

The primary role of SUPERA Park is to foster innovation and the development of technologies in the healthcare sector. The future of healthcare is shaped by global trends integrating advanced technology, sustainability, and connectivity. Innovations in artificial intelligence, the Internet of Things (IoT), augmented and virtual reality, and biotechnology are revolutionising diagnostics and treatment methodologies. Connected systems and integrated environments enable remote monitoring, community care, and personalised therapies, addressing the specific needs of individuals. Furthermore, challenges such as climate change, nutrition, and epidemiological surveillance drive the development of innovative solutions that promote well-being and disease prevention. As these technologies continue to evolve, the healthcare sector is becoming more accessible, efficient, and resilient, prioritising quality of life and positively impacting vulnerable populations worldwide.

Keywords. Innovation, Technology, Healthcare, Technological Park

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