3rd Workshop in Bioengineering

Artificial Intelligence in Medicine

Venue: Auditório I, CETEPE/EESC/USP

Date: December 18-19, 2024

Registration: Formulário Google

Contact: wbio2024@eesc.usp.br / (16) 3373-9586

Organizing and Scientific Committee:

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Speakers:

Plenary 1: Prof. Lucas Lins de Lima, UNIP Ribeirão Preto

Plenary 2: Prof. Joaquim C. Felipe, FFCLRP/USP

Plenary 3: Prof. Domingos Alves, FMRP/USP

Plenary 4: Prof. Lauro Wichert, FMRP/USP

PROGRAM OVERVIEW

Time	December 18th	December 19th
8:00 – 8:30	Registration	Registration
8:30 – 9:00	Opening	Registration
9:00 – 10:00	Plenary 1	Plenary 3
10:00 – 10:30	Coffee break	Coffee break
10:30 – 11:00	T1.1D	T3.1D
11:00 – 11:30	T1.2D	T3.2D
11:30 – 12:00	T1.3D	T3.3M
12:00 – 14:00	Lunch break	Lunch break
14:00 – 15:00	Plenary 2	Plenary 4
15:00 – 15:30	Coffee break	Coffee break
15:30 – 16:00	T2.1M	T4.1D
16:00 – 16:30	T2.2M	T4.2D
16:30 – 17:00	T2.3D	T4.3M
17:00 – 17:30	T2.4M	T4.4D

Plenary	Title	Speaker
1	Deep neural networks and machine learning applied to differentiation of primary lung tumors from metastases in computed tomography exams	Lucas Lins de Lima
2	Machine learning and infrared spectroscopy applied to histopathological diagnosis	Joaquim Cezar Felipe
3	Digital public health: Challenges and opportunities	Domingos Alves
4	Advancing the future of healthcare through innovation	Lauro Wichert Ana

Talk	Title	Presenter
T1.1D	Psychometric validation of the computer proficiency questionnaire (cpq-brazil) adapted to brazilian portuguese	Gabrieli Pereira da Cruz
T1.2D	Lung opacities multimodal prognostic evaluation using artificial intelligence	Johanna Elisabeth Rogalsky
T1.3D	Assessment of the Radiomics Pipelines for Histological Classification of Non-Small Cell Lung Cancer from Molecular Images of [18F]FDG-PET/CT	Leonardo Alexandre Santos
T2.1M	Automatic detection and segmentation of tumors in chest computed tomography exams to aid in the diagnosis and radiomics of lung cancer	Douglas Samuel Gonçalves
T2.2M	Study of machine learning models for texture characterization of vertebral bodies in magnetic resonance imaging and correlation with compression fractures	Laura Teresa Ricoboni
T2.3D	Development of a protocol for the evaluation of the effects of non-immersive virtual reality practice on the motor control of young adults	Bruna Carolina Mania Duarte
T2.4M	Knowledge, perception and attitude regarding artificial intelligence among dentists: A systematic review	Helena Cristina Aguiar
T3.1D	Effect of pH and Ionic Strength on the Antimicrobial Activity of Rhamnolipids Against Staphylococcus aureus	Amanda Mezete Gouveia
T3.2D	Printability of bioinks: a consolidated definition for future prediction models	Matheus A A Resende
T3.3M	Graphene oxide reduction process: monitoring and modeling of reaction kinetics	Alessandra Maria Garcia Barbosa

T4.1D	Nonlinear Analysis by Phase Space Reconstruction in Voice Signals with Benign Laryngeal Lesions	Mariana Ferreira Gonçalves
T4.2D	Housing Demands for a Successful Aging-In-Place: An Analysis Through the 5p's Model	Janaina Moreno Garcia
T4.3M	Health2Home - Mapping diagnostic imaging services at home and user needs: a scoping review	Giovana Fondato Costa
T4.4D	Strategies for Minimizing the Effects of Observer Variability on Sagittal Parameter Measurements of the Spine	Adimilson dos Santos Delgado

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.

Acknowledgments. The first author acknowledges the support of the Coordination for the Improvement of Higher Education Personnel (CAPES) – Finance Code 001. The institutions and programs CAPES, USP, PAE, PAP and FAPESP (process no. 2020/12528-3) provide financial support throughout the research.

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.

Acknowledgments. The author acknowledges the support of the Coordination for the Improvement of Higher Education Personnel (CAPES) – Finance Code 88887.498626/2020-00; and São Paulo Research Foundation (FAPESP) – Finance Code 2021/00633-0.

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.

Acknowledgments. The first author acknowledges the support of the São Paulo State Research Support Foundation (FAPESP) – Finance Code 2023/10203-8.

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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T1.1D - Psychometric validation of the Computer Proficiency Questionnaire (CPQ-Brazil) adapted to Brazilian Portuguese

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Abstract.
The rapid demographic transition and technological advancement emphasize the need for older adults to adapt to the digital world. However, validated tools to assess their technological skills and support digital inclusion are limited. This study aims to validate the Brazilian version of the Computer Proficiency Questionnaire, adapted to assess technological literacy in older adults. A methodological study is being conducted with 350 participants aged 60 and above, recruited nationwide. Participants completed a socio-demographic questionnaire, and the validation process includes assessments of reproducibility, reliability, and both exploratory and confirmatory factor analyses. To date, 226 older adults (mean age= 71.19 years, SD= 6.36) have participated, with 71.2% identifying as female. The average years of schooling was 12.80 (SD = 6.07), with a median of 12 years and a range of 0 to 35 years. Most participants were from the South (77.73%), followed by the Southeast (19.91%). Responses were collected via paper (42%) and online (58%). Regarding internet use, 59.3% accessed it more than once a day, 3.5% had no access, and 6.6% had access but did not use it. Most participants (68.1%) completed the questionnaire unaided. Correlation analyses revealed a weak negative relationship between age and technological proficiency (r= -0.23) and a moderate positive correlation with years of schooling (r= 0.62). The highest proficiency score was in 'Computer Basics' (mean= 3.60), while 'Diary/Calendar' had the lowest (mean= 2.33). Final results will clarify the tool's applicability.

Keywords. Older people; Education and training; Technology; Questionnaire; Psychometric validation.

Acknowledgments. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

T1.2D - Lung opacities Multimodal prognostic evaluation using Artificial Intelligence

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Abstract. Interstitial lung diseases (ILDs) compose a group of more than 200 distinct pathological processes. Despite this, they may share symptoms and features on examinations, making their differential diagnosis more difficult. The diagnosis uses the computed tomography (CT) examination, which is also present in patient management, being part of the prognosis and evaluation of the disease and the treatment efficacy. However, the visual analysis of the exams performed by radiologists is a complex task, which can be tiring and result in intra- and inter-observer variation regarding radiological and diagnostic findings. In this context, computational support has become a part of this evaluation. By associating this quantification and clinical data with a clinical outcome, radiomics has opened new avenues for subtyping and phenotyping these lung diseases. This way, computational tools able to infer the clinical outcome can assist in the diagnosis, but mainly in the longitudinal management of the patient, given an association of quantification of features extracted from CT images and data from additional exams. Retrospectively combining clinical exams and data from a group of patients with ILD enables building a model that infers the clinical outcome. Based on the above, this project aims to investigate computational models that use image registration, machine learning, and deep learning techniques, so that they can be used to perform radiomic association of multimodal data and enable the diagnostic and prognostic evaluation of patients with ILD.

Keywords. Radiomics. Interstitial Lung Diseases. Machine Learning. Deep Learning.

Acknowledgments. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

T1.3D - Assessment of the Radiomics Pipelines for Histological Classification of Non-Small Cell Lung Cancer from Molecular Images of [18F]FDG-PET/CT

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In the staging of non-small cell lung cancer (NSCLC) cases, histological assessment is gold standard in characterization of type tumor. However, viable tissue samples for evaluation is challenging, what can be more explored with radiomic techniques to aid in this classification by highlighting areas of histological heterogeneity. This study aimed to evaluate the performance of various machine learning pipelines for classifying NSCLC cases using [18F]FDG-PET-CT images. **Materials and methods**: We investigated 135 PET images of patients diagnosed with NSCLC of type adenocarcinoma (ADS) and squamous cell carcinoma (SCC), confirmed through histopathological assessment. The images were manually segmented by a nuclear medicine physician and extracted 2.082 radiomic features that could potentially contribute to histological classification. We used three feature selection methods (F-Score (ANOVA), Mutual Information (MI), and Principal Component Analysis (PCA)) along with six classification methods (Random Forest, Support Vector Machine, k-Nearest Neighbors, Gaussian Naïve Bayes, Decision Tree, and XGBoost) to build machine learning pipelines capable of differentiating between the two types of NSCLC. The model complexity and area under the curve (AUC) were used as metrics to assess the performance of the methods. **Results:** The eighteen pipelines of classification assessed evidenced good performance for XGBoost+ANOVA and MI (AUC > 0.9 to test) and increased performance for the pipeline with PCA for dimensional reduction. **Conclusion:** The radiomic machine learning methods for classifying NSCLC cases have demonstrated good performance in distinguishing [18F]FDG-PET/CT images of ADS and SCC when implemented with feature selection methods ANOVA and MI, however, compromised for the PCA method.

Keywords. Nuclear Medicine, NSCLC, PET-CT, Radiomics, Machine learning methods.

T2.1M - Automatic detection and segmentation of tumors in chest computed tomography exams to aid in the diagnosis and radiomics of lung cancer

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Abstract. Lung cancer is the type of cancer with one of the highest mortality rates in Brazil, and the highest rate in the world. With the advance of technology, systems have been created that work extensively in the medical field to help analyze these tumors in patient examinations, known as computer-aided diagnosis (CAD). The process of radiomics is an extension of CAD systems, which includes transforming images from medical examinations into data that can be interpreted by algorithms, viewing images as numbers and sequences of intensities that mathematically determine what these lesions are in the examinations, allowing important characteristics to be extracted for classifying the lesion. Convolutional neural networks (CNN) are deep learning methods used primarily in image classification, where the image is processed by multiple layers that apply filters and generic functions to extract characteristics from these images and classify them. Thus, the aim of this research is to use algorithms and methods for segmenting lung lesions and structures pertinent to the lung to create a database with images of tumors and structures that can generate a false positive in the clinical evaluation of the exam and use this database to train a CNN type neural network and assess the feasibility of creating an automated segmentation algorithm for lung lesions.

Keywords. Convolutional Neural Networks; Image Segmentation; Deep Learning; Radiomics; Automatic Segmentation.

T2.2M - Study of machine learning models for texture characterization of vertebral bodies in magnetic resonance imaging and correlation with compression fractures.

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Abstract.

Osteoporosis is a chronic osteometabolic disease characterized by reduced bone mineral density (BMD), which leads to an increased risk of fractures. The latest definitions of osteoporosis introduce the concept of bone quality, encompassing a set of structural and compositional characteristics of bone responsible for maintaining skeletal resistance to fractures. According to the World Health Organization (WHO), fragility fractures are those that occur as a result of low-energy trauma, resulting from a reduction in bone strength and reflecting skeletal fragility under biomechanical stress. In addition to causing loss of mobility, institutionalization, and increased risk of mortality, these fractures increase healthcare costs due to their high prevalence in individuals with multiple comorbidities. In the spine, compression fractures occur when the load on the vertebral body exceeds its stability, resulting in bone collapse. Studies indicate that people with osteoporotic vertebral fractures have a significantly higher risk of subsequent fractures. The measurement of bone mass through dual-energy X-ray absorptiometry (DXA) is considered the “gold standard” for the diagnosis of osteoporosis. Although validated in clinical trials and widely used for diagnosis and monitoring of the disease, DXA has limitations in predicting fracture risk in osteoporotic patients. Therefore, this project aims to develop machine learning models that complement the diagnosis performed by DXA by investigating biomarkers and characterizing the texture of non-fractured vertebral bodies, correlating them with vertebral bodies that present compression fractures.

Keywords. Osteoporosis, Bone fractures, Dual-energy X-ray absorptiometry (DXA), Machine learning models.

Acknowledgments.

We would like to thank the Faculty of Medicine of Ribeirão Preto, the School of Engineering of São Carlos and the Institute of Chemistry of São Carlos of the University of São Paulo, the Center for Imaging Sciences and Medical Physics of the Hospital das Clínicas of Ribeirão Preto, as well as the funding agency CAPES for the financial support.

T2.3D - Development of a protocol for the evaluation of the effects of non-immersive virtual reality practice on the motor control of young adults

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Abstract.

Virtual Reality (VR) can potentially contribute to health as an alternative to traditional interventions. Few studies examined young adults and the effects of these practices on motor control (MC). Moreover, there aren't studies that compared the adaptations resulting from the practice of VR (non-immersive) in this population that is considered a standard for comparison. Therefore, the primary objective was the development of a practice and assessment protocol that allows the investigation of the effects of VR practice and real practice (RP) on MC in young adults. The secondary objective was the application of the protocol developed to evaluate its applicability and feasibility. For this, (a) a protocol of practice with activities to be carried out in VR and RP was developed, as well as an evaluation protocol to compare the effects of practice with VR and RP on the MC of young adults; and (b) an application study was carried out, in which two young adults participated. The results showed (a) the process of developing the practice protocol, which included the practice of games in both practices during 18 sessions of 20 minutes, three times a week, and the assessment protocol that included assessments of postural control, heart rate variability and cortical activation before and after the intervention and one week after the intervention; and that (b) the protocol developed can be applied and proved to be viable to compare the effects of practices with VR and RP on the MC of young adults.

Keywords. Virtual reality; Motor control; Young adults.

Acknowledgments. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

T2.4M - Knowledge, perception and attitude regarding artificial intelligence among dentists: A systematic review

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Abstract. Applications of artificial intelligence in dentistry are advancing rapidly, enhancing treatment precision, reducing consultation time, and aiding in the diagnosis and prognosis of dental conditions. However, as these technologies are relatively new, several challenges arise in clinical implementation, including ethical dilemmas and the need for professional training. This review aims to understand dentists' knowledge, attitude and perception of artificial intelligence. An electronic search was conducted across PubMed, Embase, Scopus, Web of Science, Lilacs, ACM Digital Library, and Google Scholar databases, resulting in 3,132 articles, of which 630 duplicates were excluded. The remaining 2,502 articles underwent a double-blind screening process, and 48 articles were selected for full-text review. A total of 23 articles were included from the database search, and 6 were included through citation searching. The articles were assessed for risk of bias using the Joanna Briggs Institute (JBI) Checklist for Analytical Cross-Sectional Studies and were rated according to the GRADE scale for quality of evidence. Studies have shown a positive association between dentists' perceptions and the application of artificial intelligence (AI) in dentistry. Despite significant variation in professionals' knowledge levels regarding AI, most studies highlight the need to invest in training for both students and practicing professionals. Participants remain concerned with ethical issues such as data privacy, liability for errors, and algorithm transparency. Therefore, while optimism toward AI has been noted, advancements in education and ethical frameworks are essential for the successful implementation of this technology in clinical practice.

Keywords. Artificial intelligence; Dentistry; Attitude; Perception; Awareness; Systematic review

T3.1D - Effect of pH and Ionic Strength on the Antimicrobial Activity of Rhamnolipids Against *Staphylococcus aureus*

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Abstract.

Waterborne and foodborne diseases (WFD) are among the leading causes of mortality in developing countries, with bacteria being the primary pathogens involved. Among these, *Staphylococcus aureus* is notable for causing diseases through infection and food poisoning, resulting from consuming contaminated food. The increasing bacterial resistance to conventional antibiotics, combined with the interest in more sustainable antimicrobials, has driven the search for alternative control methods. In this context, the use of biosurfactants (BS), such as rhamnolipids (RL), emerges as a promising alternative due to their low toxicity, biodegradability, and production from renewable sources. This study aimed to evaluate the effect of pH and ionic strength on the antimicrobial activity of RL against planktonic and sessile forms of *S. aureus*. The results indicated that increasing the pH from 5 to 8 raised the minimum inhibitory concentration (MIC) from 78.12 mg/L to over 2500 mg/L. Moreover, the presence of NaCl enhanced the antimicrobial activity of RL at all tested pH values, reducing MIC values. Planktonic cells of *S. aureus* were more sensitive to RL treatment than biofilms. Despite the greater resistance of biofilms, the presence of RL was able to reduce the number of viable cells by up to 3.8 logarithmic units. It is concluded that both ionic strength and pH significantly influence the antimicrobial activity of RL against *S. aureus*, suggesting its potential application in acidic and salty foods.

Keywords: Ionic strength. Biosurfactant. Biofilms. Rhamnolipid. *S. aureus*.

Acknowledgments. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

T3.2D - Printability of bioinks: a consolidated definition for future prediction models

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Abstract. Printability is a term widely used nowadays for research on bioinks for additive manufacturing. Despite of this, it seems to be an absence of a common and universally accepted interpretation of the term, which can be source of misunderstanding among researchers, whereas some of them use printability and shape fidelity or shape accuracy indistinctly, other authors take into account different aspects of the printing process, such as, shape fidelity, extrudability, shape accuracy, including them as factors that, combined, lead to a more complete concept. In any case, and based on works reported in literature, a consensus is still lacking. In the case of bioprinting, cell viability is an extremely important factor to be included. This impacts any study on printability, since a partial view it would be based on a partial view of this property. For instance, studies relating rheological properties and printability and the prediction of this property on the physical properties of the inks will suffer of a generality as poor as the definition of the target property, independently of the methodology (physical modeling, machine learning, etc.). Thus, this scenario avoids any prediction of the complete manufacturing process. In this work a literature review between the years 2011 and 2023 on the concept of printability, following the evolution of the term and how it has been increasingly applied in the area. By using data science and machine learning tools, particularly text mining and text analytics, we can identify some cluster ideas leading to a general definition with greater acceptance in a wide range of different areas of application of additive manufacturing. Based on this we propose more general definition of printability in order to build such consensus.

Keywords. Printability; Bioinks; Bioprinting; Cell Viability; Predictive Models

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T3.3M - Graphene oxide reduction process: monitoring and modeling of reaction kinetics

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Abstract.

Graphene is of extreme importance due to its unique physical properties such as mechanical strength, thermal and electrical conductivity and transparency, among others, making this material ubiquitous in science. Unfortunately, obtaining this material is complex and, because of that, considerable efforts are devoted in finding mor efficient methods for large-scale and low-cost production of graphene. A viable alternative is the chemical reduction of graphene oxide. Depending on the specific application, a material with properties similar to those of the graphene can be obtained. For instance, by the reduction process the electrical conductivity of the graphene oxide, which is an insulator, can be increased resulting in conductive reduced graphene oxide. This changing in the electrical conductivity can be also used for monitoring the kinetics of the reduction process. Despite the importance of the chemical reduction of graphene oxide, there is a lack of studies of the reaction kinetics of this process, whose description would allow its optimization both in time and in cost. This work aims to show a novel scheme for real time and on-line electrical monitoring of the graphene oxide chemical reduction process. The method is teste in different reduction conditions. The electrical conductivity of the reduction solution is measured continuously during the process. A mathematical model is also proposed to determine the reduced graphene oxide concentration from conductivity according to the following expression: $m=\exp((\kappa-c)/a)-b$, where a, b and c are fitting parameters. This model was validated with other expressions found in literature for the conductivity of electrolyte solutions.

Keywords. Reduction; Kinetics; Mathematical model.

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T4.1D - Nonlinear Analysis by Phase Space Reconstruction in Voice Signals with Benign Laryngeal Lesions.

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Objective: Describe Phase Space Reconstruction (PSR) in voice signals with benign laryngeal lesions.

Method: 106 voice signals were analyzed from patients at FOB-USP, including 43 with nodules (41 women, 2 men, ages 18–50, average 32 ± 8 years), 40 with cysts (39 women, 1 man, ages 18–47, average 31 ± 8 years), and 23 with sulcus (13 women, 10 men, ages 22–48, mean 34 ± 9 years). The nonlinear analysis was performed by the Phase Space Reconstruction method through a two-dimensional graph obtained by the Voice Analysis Program. The analysis was made by the 4-point crescent scale called curves-irregularity and spacing (C-IS). Statistical analysis employed the Mann-Whitney Test with a 5% significance level.

Results: PSR graphs showed open and closed trajectories across all lesions, with predominance of 4 curves (nodules ranged from 4 to 1 curves, while cysts and sulcus ranged from 4 to 2). Grade 1 (mild) irregularity predominated in nodules, cysts, and sulcus (42%, 43%, and 52%, respectively), with irregularities ranging from 0 to 3 degrees (normal to severe). Spacing was predominantly grade 1 (small) in nodules and cysts (46% and 48%, respectively), ranging from 0 to 3 degrees, while sulcus showed predominant grade 2 (medium) spacing (52%, ranging from 0 to 2 degrees). There was no significant difference ($p>0.05$) between lesions on the C-IS scale.

Conclusion: Benign laryngeal lesions, including nodules, cysts, and sulcus, presented PSR graph with open and closed trajectories, predominance of 4 curves, mild irregularity and small to medium spacing.

Keywords. Voice. Dysphonia. Nonlinear Dynamics. Speech Acoustics. Speech, Language and Hearing Sciences

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T4.2D - HOUSING DEMANDS FOR A SUCCESSFUL AGING-IN-PLACE: AN ANALYSIS THROUGH THE 5P'S MODEL

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Summary
This study focuses on the concept of *aging-in-place* in terms of the functional, symbolic, and emotional bonds and meanings of homes and communities and how the environment is affecting well-being in old age." (WHO, 2017). **Objective:** To identify the demands of the elderly in relation to housing as a construct of AiP, based on the analysis of the 5 P's (Person, Place, Products, Services and Policies). **Methodology:** This is a retrospective, exploratory, cross-sectional, analytical and qualitative-quantitative study. 124 structured interview scripts were analyzed, about the demands of people over 50 years old from the main question "What current needs can influence your future?". The data were assessed through thematic content analysis. **Results:** Ninety-four participants were women, with a mean age of 67.7 years, married (52), with more than 10 years of schooling (61), 43 retired, and 48 participants continued to work. Two categories of analysis were listed: Housing demands, subdivided into Environment and Territory; and Demands of the elderly, which was subdivided into Personal and Third Factors. The demands of housing were expressed in the theme Built Environment, such as the need to adapt the residence; and in the Object Environment, such as the desire to purchase appliances. The demands of the elderly related to Personal Factors emerged concerns with health, finances and interpersonal relationships; and to the Third Parties he brought the knowledge of an active life in the community and in the family environment. **Conclusion:** Understanding these demands makes it possible to give voice and autonomy, favoring functional and active aging in the desired place.

Keywords: Aging in Place, Aging, Quality of Life and Autonomy

T4.3M - Health2Home - Mapping diagnostic imaging services at home and user needs: a scoping review

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Abstract: Home diagnostic imaging services are increasingly popular due to their convenience and accessibility, particularly benefiting older adults, individuals with reduced mobility, and those living in remote areas. Customizing these services to individual needs is essential. However, the lack of guidelines compromises the quality and safety of care. This scoping review aims to map studies that identify the barriers and facilitators that influence the provision of home diagnostic imaging exams services. Several steps have been completed, including developing a search strategy using descriptors like diagnostic imaging, portable, home, and perceptions, and conducting searches in databases such as PubMed, Web of Science, Scopus, Embase, ACM Guide to Computing Literature, and Lilacs, without restrictions on publication date or language. A supplementary search was performed using Google Scholar. Two reviewers independently selected studies based on titles, abstracts, keywords, and full text, applying predefined inclusion criteria. The data analysis phase is currently underway. Quantitative data will be analyzed for mean, standard deviation, and frequency, while qualitative data will be categorized using content analysis. Partial results showed that of 1,471 studies identified, 25 were included, with 64% published after 2019 and covering 15 countries. The main diagnostic services studied include X-ray, electrocardiogram, electroencephalogram, and polysomnography. Expected outcomes include generating a list of design concept guidelines for home diagnostic imaging services aligned with user needs, along with identifying and categorizing barriers and facilitators of these services. These findings will support the Brazilian Health System (SUS) and companies in improving accessibility and implementation of these services.

Keywords. Diagnostic imaging; Portable; Residence; User-centered design.

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T4.4D - Strategies for Minimizing the Effects of Observer Variability on Sagittal Parameter Measurements of the Spine

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Abstract. Objective: Evaluate the influence of observer variability on thoracic kyphosis (TK) and lumbar lordosis (LL) measurements obtained with anatomical and functional spinal segmentation methods. **Background**: Spinal surgery planning typically relies on anatomical parameters. However, incorporating functional parameters that consider vertebrae orientation is important to minimizing surgical calculation errors. **Methods**: The authors developed parametric analysis software integrating traditional and functional methodologies. The proposed method included functional TK and functional LL calculated from the lines normal to the inflection points of the spine model. Using a synthetic lateral X-ray, the observer variability was computer-simulated by generating 20 landmark sets replicating 20 observers' annotations. The analysis also included 10 clinical X-rays, annotated twice by three judges with a one-week interval. Spinal curvature angles were derived using the anatomical and functional methods. Statistical analysis were performed. **Results**: For the synthetic X-ray, the proposed method presented significantly less variability: TK (<±2.5°, p=0.00023) and LL (<±5°, p=0.00012). For the clinical X-rays, interobserver reliability was higher for functional TK (ICC>0.97) and LL (ICC>0.87) compared to anatomical TK (ICC <0.91) and LL (ICC<0.89). Statistically significant differences were observed for both TK (p=0.001) and LL (p=0.030). Under the traditional method, observer variability led to measurement differences surpassing ±19°, whereas differences with the proposed method were within ±10° for both parameters. **Conclusion**: The vertebral endplate is not the most suitable place to measure spinal sagittal curvatures. Small changes in landmark position significantly alter the measured Cobb angle. The proposed method offers a substantial advantage regarding the influence of observer variability.

Keywords. Sagittal alignment; Spinopelvic parameters; Vertebral parameters; Inflection point; Functional segmentation.